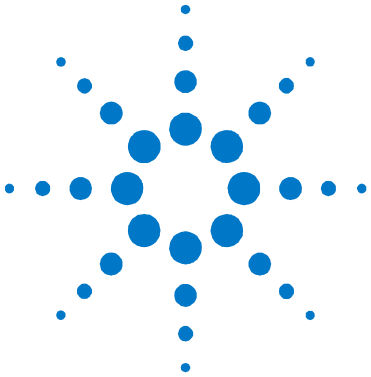

Agilent Technologies Modular Power System

Series N6700

User's Guide

Agilent Technologies

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Safety Notices

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or instructions elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

General

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the unit before applying power. Note the instrument's external markings described under "Safety Symbols"

Ground the Instrument

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Fuses

The instrument contains an internal fuse, which is not customer accessible.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Agilent Sales and Service Office for service and repair to ensure that safety features are maintained.

In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Safety Symbols

Direct current

Alternating current

Both direct and alternating current

Three phase alternating current

Earth (ground) terminal

Protective earth ground terminal.

Frame or chassis terminal

Terminal is at earth potential.

Neutral conductor on permanently installed equipment

Line conductor on permanently installed equipment.

On supply

Off supply

Standby supply. Unit is not completely disconnected from ac mains when switch is off

In position of a bi-stable push switch

Out position of a bi-stable push switch

Caution, risk of electric shock

Caution, hot surface

Caution, refer to accompanying description

In this Book

Specific chapters in this manual contain the following information:

- Quick Reference – Chapter 1 is a quick reference section that helps you quickly become familiar with your Agilent N6700 Modular Power System. It describes the differences between the various modules in the power system.
- Installation – Chapter 2 describes how to install your power system. It describes how to connect various loads to the output. It discusses remote sensing as well as parallel and series operation.
- Getting Started – Chapter 3 describes how to set the voltage, current, over-voltage protection, and turn on the output. It also describes how to configure the remote interface.
- Operating the Power System – Chapter 4 describes how to use the advanced features of the power system using the front panel menus and the corresponding SCPI commands.
- Introduction to Programming – Chapter 5 gives a brief overview of the SCPI command structure and basic programming concepts.
- Language Dictionary – Chapter 6 describes all of the SCPI programming commands.
- Programming Examples – Chapter 7 provides Visual Basic example programs that illustrate some common applications.
- Specifications – Appendix A describes specifications and supplemental characteristics.
- Verification and Calibration Procedures – Appendix B explains the verification and calibration procedures.
- Using the Digital Port – Appendix C describes how to configure and use the digital port on the back of the instrument.
- Service – Appendix D describes what to do if your unit requires service.
- Compatibility – Appendix E documents the compatibility commands of the Agilent Series 662xA DC power supplies that are supported by the Agilent N6700 Modular Power System.

NOTE

If you have questions relating to the operation of the Agilent N6700 Modular Power System, call 1-800-452-4844 in the United States or contact your nearest Agilent Technologies Sales Office.

The web contains the most up-to-date version of the manual. Go to http://www.agilent.com/find/N6700.

Instrument drivers for Agilent Technologies products are available on the web at http://www.agilent.com/find/drivers.

Contents

1 Quick Reference 7

The Agilent N6700 Modular Power System – At a Glance 8
The Front Panel - At a Glance 10
The Rear Panel – At a Glance 10
Front Panel Display – At a Glance 11
Front Panel Keys – At a Glance 11

2 Installation 13

General Information 14
Inspecting the Unit 15
Installing the Unit 15
Connecting the Line Cord 17
Connecting the Outputs 18
Remote Sense Connections 22
Parallel Connections 23
Series Connections 24

3 Getting Started 27

Turning the Unit On 28
Selecting an Output Channel 28
Entering an Output Voltage Setting 28
Entering a Current Limit Setting 29
Enabling the Output 29
Using the Front Panel Menu 30
Configuring the Interface 34

4 Operating the Power System 39

Programming the Output 40
Synchronizing Output Steps 42
Making Measurements 45
System Related Operations 46
Programming High-Speed Test Extensions 49

5 Introduction to Programming 59

SCPI Commands 60
SCPI Messages 62
SCPI Conventions and Data Formats 64
SCPI Command Completion 66
Device Clear 66

6 Language Dictionary 67

SCPI Command Summary 68
Calibration Subsystem 72
Measurement Subsystem 74
Output Subsystem 77
Source Subsystem 80
Status Subsystem 87
System Commands 94
Trigger Subsystem 97

7 Programming Examples 99

Output Programming Example 100
List Programming Example 102
Digitizer Programming Example 104

A Specifications 107

Performance Specifications 108
Supplemental Characteristics 110
Auto-Ranging Characteristic 115
Outline Diagram 115

B Verification and Calibration 117

Verification 118
Calibration 133

C Using the Digital Port 143

Digital Control Port 144
Configuring the Digital Control Port 148

D Service 151

Types of Service Available 152
Operating Checklist 152
Repackaging for Shipment 152
Disassembly 153
Error Messages 156

E Compatibility 161

Differences – In General 162
Compatibility Command Summary 163

Index 167

1
Quick Reference

The Agilent N6700 Modular Power System – At a Glance 8

The Front Panel - At a Glance 10

The Rear Panel – At a Glance 10

Front Panel Display – At a Glance 11

Front Panel Keys – At a Glance 11

This chapter concisely describes the operation of the Agilent N6700 Modular Power System (MPS).

This chapter does not describe every operating feature in detail. It is simply a quick reference guide to quickly become familiar with the essential operating features of the power system.

A map of the front panel command structure is found in chapter 3.

A quick reference programming command chart is included in the beginning of chapter 6.

NOTE Unless otherwise noted, the Agilent N6700 Modular Power System will also be referred to as "MPS" and "power system" throughout this manual.

The Agilent N6700 Modular Power System – At a Glance

The Agilent N6700 Modular Power System is a configurable platform that lets you mix and match output modules to create a power system that is optimized for your test system requirements.

Up to four output modules can be installed in each Agilent N6700A Mainframe. Output modules come in power levels of 50 and 100 Watts, have various voltage and current combinations, and provide the following output performance levels:

- The N675xA High-Performance, Autoranging DC Power Modules provide low noise, high accuracy, fast programming times, and advanced programming and measurement capabilities to speed test throughput.
- The N676xA Precision DC Power Modules provide precise control and measurements in the milli- and micro-ampere region with the ability to simultaneously digitize voltage and current and capture those measurements into an oscilloscope-like data buffer.
- The N673xA and N674xA DC Power Modules provide programmable voltage and current, measurement, and protection features, making these economical modules suitable for powering the device-under-test or system resources such as fixture controls.

The output and system features are described in the following sections. Not all output features are available on every power module. The “Model Differences” section describes the features that apply only to specific power modules.

Output Features

Programmable voltage and current	Full programming capability is provided for the entire range of output voltage and current. Outputs can operate as either constant voltage (CV) or constant current (CC) sources.
Fast command processing	Command processing time of less than 1 millisecond per command.
Fast up/down programming	1.5 millisecond response time from 10% to 90% of the output rating for auto-ranging and precision power modules. Refer to Appendix A for details.
Fast transient response	Transient response is less than 100 microseconds for auto-ranging and precision power modules. Refer to Appendix A for details.
Low output noise	Output noise is typically 4 mV peak-to-peak for auto-ranging and precision power modules, which is comparable to linear supplies. Refer to Appendix A for details.
Auto-ranging capability	Auto-ranging produces the maximum rated power over a wide and continuous range of voltage and current settings for auto-ranging and precision power modules. Refer to Appendix A for details.
Output On/Off sequencing	A turn-on/turn-off delay capability for each output allows output on/off sequencing.

Remote voltage sensing Two remote sensing terminals are provided for each output. When shipped from the factory, the remote sense terminals are strapped for local sensing. Refer to Chapter 2 for details.

Voltage and current measurements All output modules can measure their own output voltage and current.

Voltage, current, and temperature protection Each output has over-voltage, over-current, and over-temperature protection. Over-voltage and over-current protection are programmable. When activated, the protection circuits cause the voltage to go to zero, the output to be disabled, and the protection status to be reported.

System Features

SCPI language The instrument is compatible with the Standard Commands for Programmable Instruments (SCPI).

Choice of three interfaces GPIB (IEEE-488), LAN, and USB (mini B) remote programming interfaces are built in.

Front panel I/O setup Menus let you set up GPIB and LAN parameters from the front panel. Refer to Chapter 3 for details.

Built-in Web server A built-in Web server lets you control the instrument directly from an internet browser on your computer.

Real-time status information The front panel indicates the status of each output. It also indicates when a protection shut-down has occurred. Refer to Chapter 3 for details.

Module identification Each module has identifying data stored in non-volatile memory. Information includes model number, serial number, and options. This information can be displayed on the front panel.

Model Differences

Feature	DC Power Modules		Auto-Ranging Modules		Precision Modules	
	N6731A - N6735A	N6742A - N6745A	N6751A	N6752A	N6761A	N6762A
Output power rating	50 W[1]	100 W[2]	50 W	100 W	50 W	100 W
Auto-ranging output capability	NO	NO	YES	YES	YES	YES
Precision output and measurement capability	NO	NO	NO	NO	YES	YES
Low voltage output and measurement range	NO	NO	NO	NO	YES	YES
Low current output and measurement range	NO	NO	NO	NO	YES	YES
Simultaneous voltage and current measurement	NO	NO	NO	NO	YES	YES
Output list capability (Test Extensions)	NO	NO	Option	Option	YES	YES
Array readback capability (Test Extensions)	NO	NO	Option	Option	YES	YES
Programmable sample rate (Test Extensions)	NO	NO	Option	Option	YES	YES

[1]Model N6735A has a maximum output of 40 W.

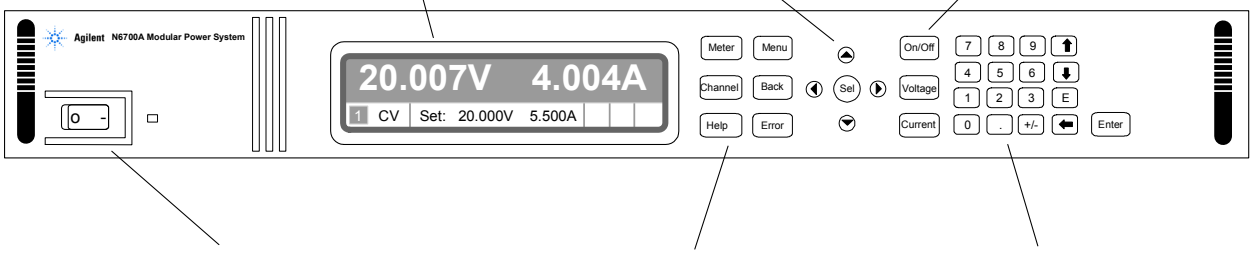
[2]Models N6742A and N6745A have a maximum output of 80 W.

The Front Panel - At a Glance

Display
Turns off after 1 hour of inactivity. Press any key to restore the display.

Navigation keys
Move the cursor to a menu item.
Select the highlighted menu item.

Output keys
Turn the outputs on or off.
Enter voltage or current.



On/Off switch and LED
LED indicates power is on.
Green = normal operation.
Amber = display is screen-saver mode.

System keys
Toggle between meter mode and the command menus.
Exit a menu and return to meter mode.
Select an output channel to display.

Numeric entry keys
Enter values.
Increment or decrement values.

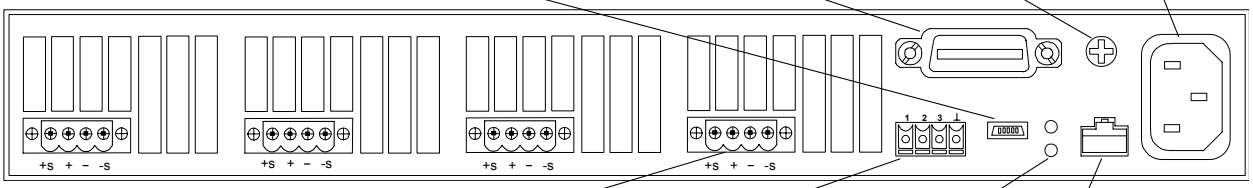
The Rear Panel – At a Glance

USB "mini-B" connector

GPIB connector

Chassis ground binding post

3-pin IEC 320 ac input connector
Power cord requires ground conductor.



4-pin output connector.
Includes +/–output and +/– sense terminals.

4-pin digital control connector
Connector function is user-configurable.

Activity indicators
Top LED indicates activity. Bottom LED indicates link integrity.

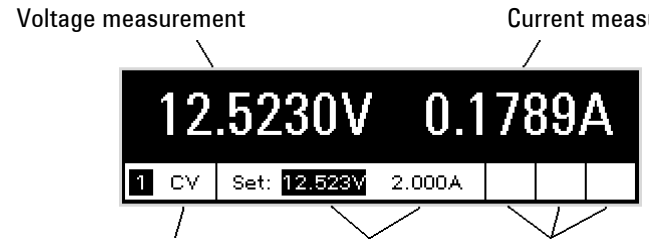
LAN connector
10/100 Base-T

WARNING **SHOCK HAZARD The power cord provides a chassis ground through a third conductor. Be certain that your power outlet is of the three-conductor type with the correct pin connected to earth ground.**

Front Panel Display – At a Glance

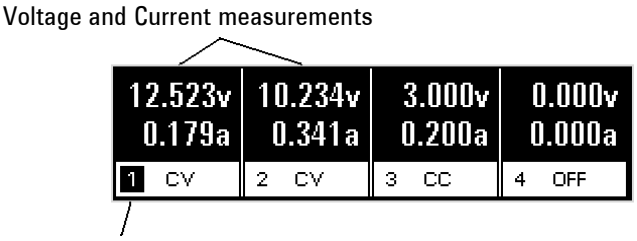
Single-channel View

Press the Meter key to toggle between views



Multiple-channel View

Press the Meter key to toggle between views



Front Panel Keys – At a Glance

System Keys

Meter Menu Channel Back Help Error

Meter returns the display to metering mode.
Menu accesses the command menu.
Channel selects or highlights a channel to control.
Back backs out of a menu without activating any changes.
Help accesses information about the displayed menu control.
Error displays any error messages in the error queue.

Navigation Keys

Sel

The arrow keys let you move around in the command menus.
The Select key lets you make a selection in the command menus.
It also lets you enter edit mode for numeric parameters.

Output Keys

On/Off Voltage Current

On/Off controls the selected output (or all outputs when ALL is lit).
This key is only active in Single- channel or Multiple-channel view.
Voltage lets you change the voltage setting of the selected channel.
Current lets you change the current setting of the selected channel.

Number Keys

7 8 9 ⬆
4 5 6 ⬇
1 2 3 E
0 . +/- ⬅ Enter

The number keys let you enter digits from 0 to 9 and a decimal point.
The minus sign is selected by the +/– key.
The exponent must be added to the right of the E symbol.
The backspace key deletes digits as it backspaces over them.
⬆ ⬇ arrow keys increment or decrement the value in certain fields. They are also used to select letters in alphabetic entry fields.
The Enter key enters a value. If you exit a field without pressing the Enter key, the value is ignored.

2 Installation

General Information 14

Inspecting the Unit 15

Installing the Unit 15

Connecting the Line Cord 17

Connecting the Outputs 18

Remote Sense Connections 22

Parallel Connections 23

Series Connections 24

This chapter describes how to install your power system. It discusses installation, rack mounting, and line cord connections.

This chapter discusses how to connect your load to the output terminals. It discusses what you need to know about wire sizes and how to compensate for voltage drops in the load leads. It also discusses various loads configurations and how to connect the output terminals in series and parallel.

NOTE Detailed information on configuring the remote interfaces is included in the Agilent Technologies *USB/LAN/GPIB Interfaces Connectivity Guide*, which you can download from the Agilent web site at http://www.agilent.com/find/connectivity.

Before installing the instrument, check the list under "Items Supplied" and verify that you have received these items with your instrument. If anything is missing, please contact your nearest Agilent Sales and Support Office.

General Information

Models

Agilent Model	Description
N6700A	MPS Mainframe - without DC Power Modules
N6721A – N6729A	Pre-configured models for compatibility. Refer to Appendix E.
N6731A	50 W 5 V DC Power Module
N6732A / N6742A	50 W / 80 W 8 V DC Power Module
N6733A / N6743A	50 W / 100 W 20 V DC Power Module
N6734A / N6744A	52.5 W / 105 W 35 V DC Power Module
N6735A / N6745A	40 W / 80 W 50 V DC Power Module
N6751A / N6752A	50 W / 100 W High-Performance Auto-ranging DC Power Module
N6761A / N6762A	50 W / 100 W Precision DC Power Module

Items Supplied

Item	Description	Agilent Part Number
Power Cord	A power cord appropriate for your location.	Call Agilent Sales & Support Office
Output Connector	A 4-pin connector for connecting power and remote sense leads.	1253-5826
Digital Connector	A 4-pin connector for connecting signal lines to the digital port.	1253-5830
Sense Jumpers	2 jumpers per module to connect the sense to the output terminals.	8120-8821
Filler Module	Only provided if there are less than four modules installed.	5002-2813
User's Guide	Contains installation, checkout, and front panel information.	5969-2908
Rack Mount Kit	A kit for rack mounting in a 19-inch EIA rack cabinet. Includes:	N6700-60009
	2 - Front Ears	5002-2816
	2 - Rear Ears	5002-2815
	2 - Rear Ear extender support	5002 2814
	6 – Front ear attachment screws (8-mm)	0515-0372
	4 – Rear extender attachment screws (6-mm)	0515-0430
	4 – Front rail dress screws	0570-1577
	6 – Rear rail screws	2680-0281
	10 – Sheet metal clip-nuts for attaching to rack frame	0590-0804

Options

Option	Description
054	High-speed Test Extensions. Includes digitized output measurements and output list capability. Available for Agilent Models N6751A/N6752A. Included with Agilent Models N6761A/N6762A
761	Output relays. Includes 2 - DPDT galvanic-disconnect relays. Disconnects both output and sense terminals. Available for all Agilent Models

Inspecting the Unit

When you receive your power system, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the shipping carrier and nearest Agilent Sales and Support Office immediately. Refer to Appendix D for more information.

Until you have checked out the power system, save the shipping carton and packing materials in case the unit has to be returned.

Installing the Unit

Safety Considerations

This power system is a Safety Class 1 instrument, which means it has a protective earth terminal. That terminal must be connected to earth ground through a power source equipped with a ground receptacle.

Refer to the Safety Summary page at the beginning of this guide for general safety information. Before installation or operation, check the power system and review this guide for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places throughout this Guide.

Environment

WARNING **Do not operate the instrument in the presence of flammable gasses or fumes**

The environmental conditions of the instrument are documented in Appendix A. Basically, the instrument should only be operated indoors in a controlled environment.

The dimensions of your instrument as well as an outline diagram are given in Appendix A. A fan cools the power system by drawing air through the sides and exhausting it out the back. The instrument must be installed in a location that allows sufficient space at the sides and back of the unit for adequate air circulation.

Rack Installation

Do not block the air intake and exhaust at the sides of the unit or the exhaust at the rear of the unit. Refer to the outline diagram in Appendix A.

CAUTION **You cannot use support rails for rack mounting your instrument** as they would block the airflow needed for cooling. Use the Rack Mount kit to rack mount your instrument. The Rack Mount Kit is shipped with your instrument and is also available by ordering part number N6700-60009.

The Agilent N6700 MPS can be mounted in a 19-inch EIA rack cabinet. The rack kit parts are listed at the beginning of this chapter. Install the rack mount kit as illustrated in the following figure.

Step 1. Install eight clip-nuts on the rack frame (2 in each corner) where your instrument will be located

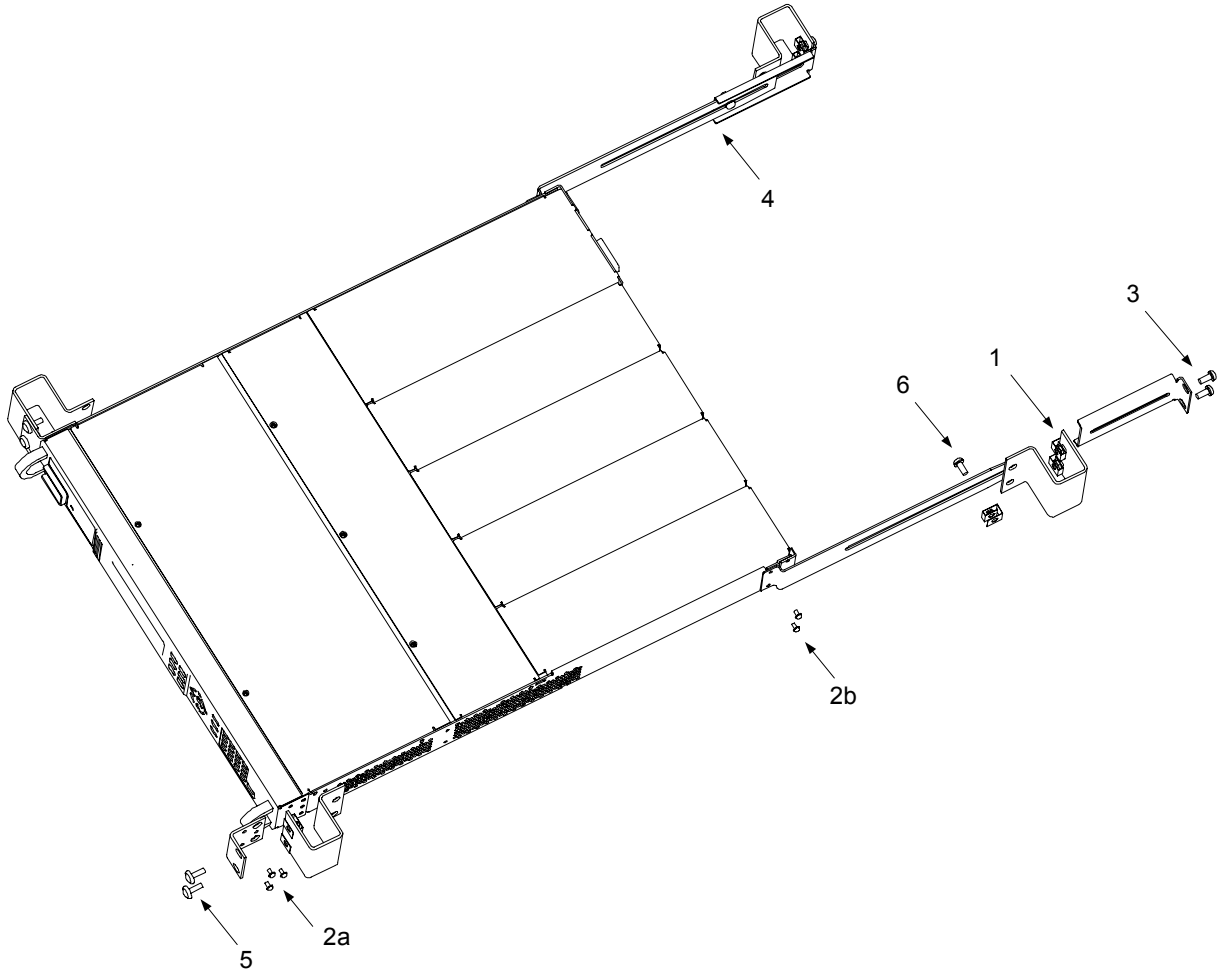
Step 2. Install the two front rack ears and the two rear extenson brackets on the instrument as shown in the figure. Use six M3 x 8mm screws (a) for the front ears and four M3 x 6mm screws (b) for the rear brackets.

Step 3. Install the two rear rack ears to the back of the instrument rack as shown in the figure. Use the four plain 10-32 screws to install the rack ears.

Step 4. Slide the unit into the rack. making sure that the rear extension brackets align themselves inside the rear rack ear brackets.

Step 5. Attach the front rack ears to the front of the instrument rack using the four dress 10-32 screws provided.

Step 6. This is optional. Insert a 10-32 locking screw through the slot of each extention bracket. Attach it with a clip-nut. Note that this will prevent the unit from being slid out of the front of the rack.



Bench Installation

Do not block the air intake and exhaust at the sides of the unit or the exhaust at the rear of the unit. Refer to the outline diagram in Appendix A.

Minimum clearances for bench operation are 2 inches (51 mm) along the sides and back.

Channel Number

The channel number of a specific module is determined by the location of that module in the mainframe. When viewed from the rear, the module next to the GPIB connector is always output channel one. Numbering continues sequentially to the left, from one to four.

If there are less than four modules, channel numbering corresponds to the number of installed modules. Unused channel slots contain filler modules to ensure proper cooling.

Cleaning

WARNING **SHOCK HAZARD To prevent electric shock, unplug the unit before cleaning.**

Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

Connecting the Line Cord

WARNING **FIRE HAZARD Use only the power cord that was supplied with your instrument. Using other types of power cords may cause overheating of the power cord, resulting in fire.**

SHOCK HAZARD The power cord provides a chassis ground through a third conductor. Be certain that your power outlet is of the three-conductor type with the correct pin connected to earth ground.

Connect the power cord to the IEC 320 connector on the rear of the unit. If the wrong power cord was shipped with your unit, contact your nearest Agilent Sales and Support Office. Refer to Appendix D for more information.

The AC input on the back of your unit is a universal AC input. It accepts nominal line voltages in the range of 100 Vac to 240 VAC. The frequency can be either 50 Hz or 60 Hz.

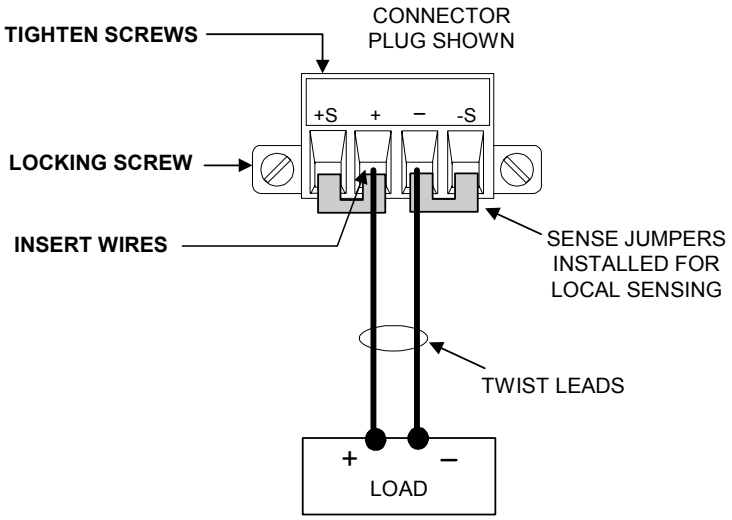
NOTE The detachable power cord may be used as an emergency disconnecting device. Removing the power cord will disconnect ac input power to the unit.

Connecting the Outputs

WARNING **SHOCK HAZARD Turn off AC power before making rear panel connections. All wires and straps must be properly connected with the terminal block screws securely tightened.**

Disconnect the connector plug to make your wire connections. The connector accepts wires sizes from AWG 12 to AWG 30. Note that wire sizes smaller than AWG 20 are not recommended. Each connector has four openings for attaching wires (see figure below). Load connections are made at the + and - terminals. Sense connections are made on the +s and -s terminals. Securely fasten the wires by tightening the screw terminals.

After your wires are securely connected, insert the connector plug into the back of the unit and secure it by tightening the locking screws. A chassis ground binding post is available next to the AC input connector for your convenience.



Wire Size

WARNING **FIRE HAZARD Select a wire size large enough to carry short-circuit current without overheating. To satisfy safety requirements, load wires must be heavy enough not to overheat while carrying the short-circuit output current of the unit (refer to the following chart).**

Along with conductor temperature, you must also consider voltage drop when selecting wire sizes. The following chart lists the resistivity for various wire sizes and also the maximum lengths to limit the voltage drop to 1.0 volts for various currents.

Wire size	Current-carrying capacity (Amps)		Resistance	Max. Length to Limit Voltage to 1 V/Lead		
				for 5 A	for 10 A	for 20A
AWG	**2 wires bundled**	**4 wires bundled**	**Ω/foot**	**Wire length in feet**		
20	7.8	6.9	0.0102	20	10	5
18	14.5	12.8	0.0064	30	15	7.5
16	18.2	16.1	0.0040	50	25	12.5
14	29.3	25.9	0.0025	--	40	20
12	37.6	33.2	0.0016	--	--	30
Area in mm²	**2 wires bundled**	**4 wires bundled**	**Ω/meter**	**Wire length in meters**		
0.5	7.8	6.9	0.0401	5	2.4	1.2
0.75	9.4	8.3	0.0267	7.4	3.8	1.8
1	12.7	11.2	0.0200	10	5	2.6
1.5	15.0	13.3	0.0137	14.6	7.2	3.6
2.5	23.5	20.8	0.0082	--	12.2	6

Notes: 1. Capacity for AWG wires derived from MIL-W-5088B. Max. ambient temp: 55°C. Max. wire temp: 105°C.
2. Capacity for metric wires are derived from IE Publication 335-1.
3. Capacity of aluminum wire is approximately 84% of that listed for copper wire.
4. Because of wire inductance considerations, it is recommended that you keep your load leads twisted, tie wrapped, or bundled together and less than 50 feet (14.7 meters) in length per lead.

Note that the minimum wire size required to prevent overheating as shown in the above chart may not be large enough to prevent OV trip and to maintain good regulation. Under most conditions, the load wires should be heavy enough to limit the voltage drop to no more than l.0 V per lead.

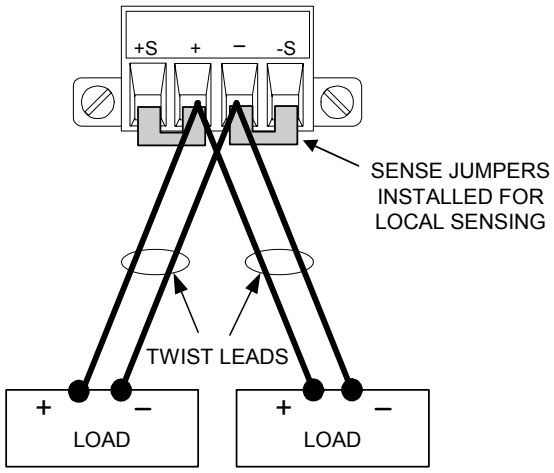
NOTE To help prevent nuisance tripping of the over-voltage circuit, select a wire size sufficient to handle the FULL output current of the unit no matter what the intended load current or current limit setting

Load lead resistance is an important factor relating to the CV stability of the instrument when remote sensing capacitive loads. If high capacitance loads are expected, you should not use wire gauges heavier than 12 to 14 AWG for long runs of load lead.

Multiple Loads

If you are using the as-shipped terminal block strapping pattern (local sensing) and are connecting multiple loads to one output, connect each load to the output terminals using separate connecting wires (see the figure below). This minimizes mutual coupling effects and takes full advantage of the power system's low output impedance. Each pair of wires should be as short as possible and twisted or bundled to reduce lead inductance and noise pickup.

If load considerations require the use of distribution terminals that are located away from the instrument, connect the output terminals to the remote distribution terminals by a pair of twisted or bundled wires. Connect each load to the distribution terminals separately. Remote voltage sensing is recommended under these circumstances. Sense either at the remote distribution terminals or, if one load is more sensitive than the others, directly at the critical load.



Positive and Negative Voltages

Either positive or negative voltages can be obtained from the output by grounding (or "commoning") one of the output terminals. Always use two wires to connect the load to the output regardless of where or how the system is grounded. The instrument can be operated with any output terminal ± 240 VDC including output voltage from ground.

Response Time with an External Capacitor

When programming with an external capacitor, voltage response time may be longer than that specified in Appendix A. Use the following formula to estimate the additional response time for up programming:

$$\text{Response Time} = \frac{(\text{Added Output Capacitor}) \times (\text{Change in Vout})}{\text{Current Limit Setting}}$$

Note that programming into an external output capacitor may cause the power system to briefly enter constant current or constant power operating mode, which adds additional time to the estimation.

Remote Voltage Sensing

Because of the unavoidable voltage drop developed in the load leads, the terminal block strapping patterns discussed thus far do not provide the best possible voltage regulation at the load. The remote sensing connections shown in the figure below improve the voltage regulation at the load by monitoring the voltage there instead of at the output terminals. This allows the power system to automatically compensate for the voltage drop in the load leads.

Remote sensing is especially useful for CV operation with load impedances that vary or have significant lead resistance. It has no effect during CC operation. Because sensing is independent of other power system functions, remote sensing can be used regardless of how the power system is programmed. Note that with remote sensing, the voltage readback circuit monitors the load voltage through the sense terminals.

NOTE The OVP circuit senses at the main output terminals and not through the sense terminals. Due to the voltage drop in the load leads, the voltage sensed by the OVP circuit could be higher than the voltage being regulated at the load. Therefore, you must take into account the additional voltage drop in the load leads when setting the over-voltage trip point.

Remote Sense Connections

Remember to turn off the power system before making or changing any connections on the rear panel terminal blocks. Connect the unit for remote sensing by first disconnecting the straps between sense and load terminals. Make your connections as shown in the previous figure. Connect the sense leads as close to the load as possible. Refer to the “Wire Size” section for information about selecting the proper wire size. Best results are obtained by using the shortest load leads practical. It is recommended that you keep your load leads under 14.7 meters (50 feet) per lead because of inductance effects.

The sense leads carry only a few milliamperes of current and therefore, can be lighter gauge than the load leads. However, note that any voltage drop in the sense leads can degrade the voltage regulation of the instrument. Try to keep the sense lead resistance less than about 0.5Ω per lead (this requires 20 AWG or heavier for a 50 foot length).

Open Sense Leads

The sense leads are part of the output's feedback path. Connect them in such a way so that they do not inadvertently become open circuited. The power system includes protection resistors that reduce the effect of open sense leads during remote-sensing operation. If the sense leads open during operation, the power system returns to the local sensing mode, with the voltage at the output terminals approximately 1% higher than the programmed value.

Output Noise Considerations

Any noise picked up on the sense leads will appear at the output terminals and may adversely affect CV load regulation. Twist the sense leads or use a ribbon cable to minimize the pickup of external noise. In extremely noisy environments it may be necessary to shield the sense leads. Ground the shield at the power system end only; do not use the shield as one of the sensing conductors.

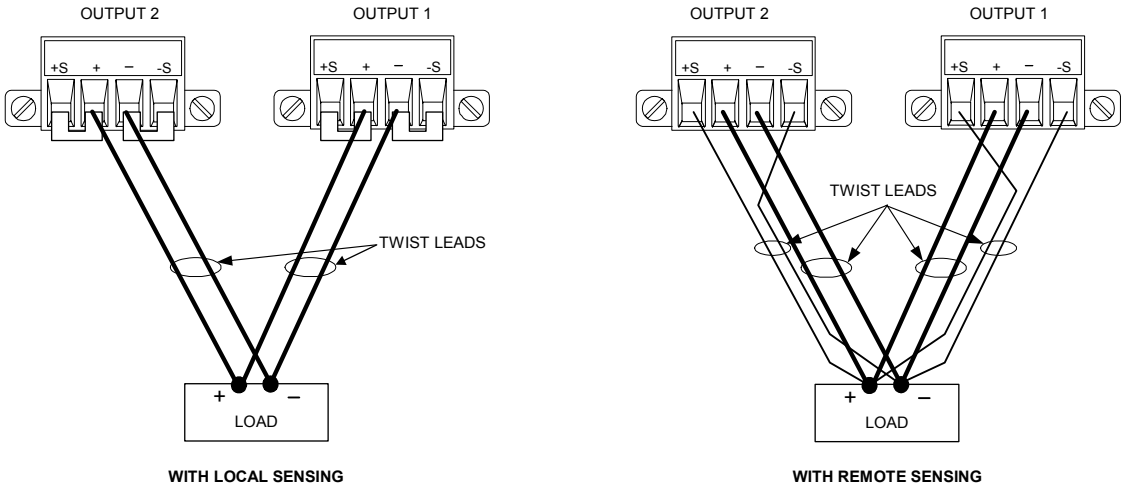
The noise specifications in Appendix A apply at the output terminals when using local sensing. However, voltage transients may be produced at the load by noise induced in the leads or by load current transients acting on the inductance and resistance of the load lead. If it is desirable to keep voltage transient levels to a minimum, place an aluminum or a tantalum capacitor, with an approximate value of 10 µF per foot (30.5cm) of load lead, right across the load.

Parallel Connections

CAUTION Only outputs that have equivalent voltage and current ratings can be connected in parallel.

Connecting outputs in parallel provides a greater current capability than can be obtained from a single output. Only parallel outputs that have equivalent voltage and current capability.

As an example, the figure on the left shows how to connect two outputs in parallel to a single load with local sensing.. If it is necessary to remote voltage sense at the load, parallel the sense leads of output 1 with the sense leads of output 2 and connect to the load as shown in the figure in the right.



Setting the Outputs

Program both outputs to the desired output voltage. Then program the current limit point of each output. The current limit point of the paralleled outputs will be the sum of both individual current limit points. The output current of the parallel combination will be the algebraic sum of the individual current readbacks.

NOTE The operating mode of each paralleled output channel is determined by the channel's programmed settings, operating point, and load condition. Because these conditions may change during parallel operation, the status annunciators on the front panel will reflect these changes. This is normal. Momentary status changes are also normal.

Effect on Specifications

Specifications for outputs operating in parallel can be obtained from the specifications for single outputs. Most specifications are expressed as a constant or as a percentage (or ppm) plus a constant. For parallel operation, the percentage portion remains unchanged while constant portions or any constants are changed as indicated below. For current readback accuracy and temperature coefficient of current readback, use the minus current specifications:

Current All parallel specifications referring to current are twice the single output specification except for programming resolution, which is the same for both single output and parallel output operation.

Voltage All parallel specifications referring to voltage are the same as for a single output except for CV load effect, CV load cross regulation, CV source effect, and CV short term drift. These are all twice the voltage programming accuracy (including the percentage portion) at all operating points.

Load Transient Recovery Time Load transient specifications are typically twice the single output .

Series Connections

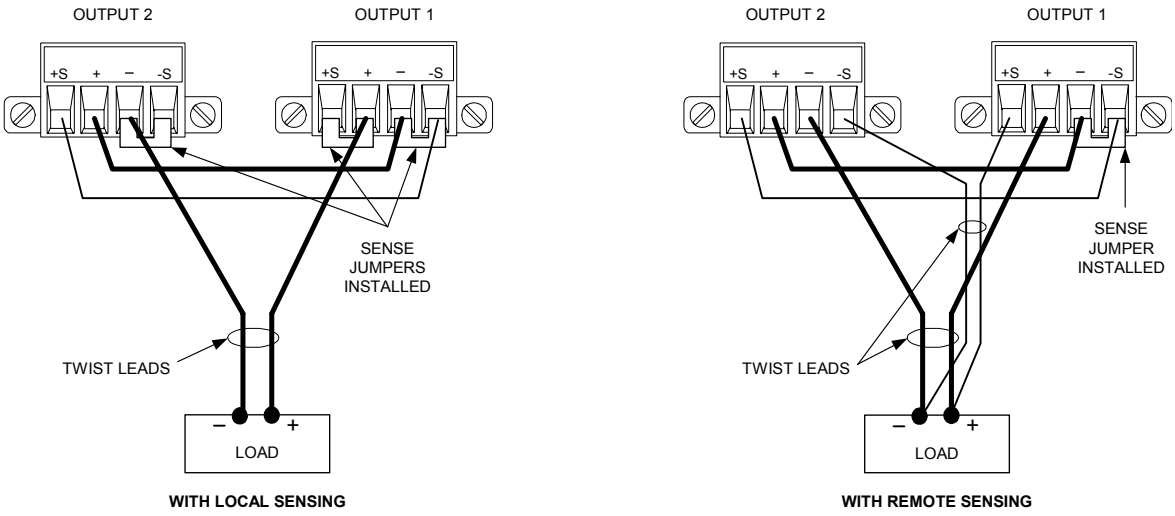
WARNING **SHOCK HAZARD Floating voltages must not exceed 240 VDC. No output terminal may be more than 240 VDC from chassis ground.**

CAUTION Connect in series only outputs that have equivalent current ratings. Each output has reverse voltage protection diodes across its output terminals. The current conducted by this diode is not internally limited by the output. Never connect an output in such a way that the diodes will conduct current in excess of the rated current of the output since damage could result.

Connecting outputs in series provides a greater voltage capability than can be obtained from a single output. Because the current is the same through each element in a series circuit, only connect outputs in series that have equivalent current ratings.

The following figure shows an example of how to connect two outputs in series to a single load with local sensing.. Connecting the + S terminal of output 2 to the - S terminal of output 1 and removing the sense jumper (between + S and + V) on output 2 compensates for the IR drop in the load lead from output 2 to output 1.

If it is necessary to remote voltage sense at the load, connect the sense leads of output 1 and output 2 as shown in the figure. The + sense lead of output 2 must remain connected to the -sense terminal of output 1. The outputs may be set as previously described.



Setting the Outputs

First program the current limit of each output to the total desired current limit point. Then program the voltage of each output so that the sum of both voltages equals the total desired operating voltage. The simplest way to accomplish this is to program each output to one half of the total desired operating voltage.

NOTE The operating mode of each output channel is determined by the channel's programmed settings, operating point, and load condition. Because these conditions may change during parallel operation, the status annunciators on the front panel will reflect these changes. This is normal. Momentary status changes are also normal.

Specifications for Series Operation

Specifications for outputs operating in series can be obtained from the specifications for single outputs. Most specifications are expressed as a constant or a percentage (or ppm) plus a constant. For series operation, the percentage portion remains unchanged while constant portions or any constants are changed as indicated.

Voltage All series specifications referring to voltage are twice the single output specification except for programming resolution, which is the same as for a single output.

Current All series specifications referring to current are the same as for a single output except for CC load effect, CC load cross regulation, CC source effect, and CC short term drift which are twice the current programming accuracy (including the percentage portion).

Load Transient Recovery Time Load transient specifications are typically twice the single output .

3
Getting Started

Turning the Unit On 28

Selecting an Output Channel 28

Entering an Output Voltage Setting 28

Entering a Current Limit Setting 29

Enabling the Output 29

Using the Front Panel Menu 30

Configuring the Interface34

This chapter describes how to get started using your power system. It discusses turning the unit on, using the front panel controls, and navigating the front panel command menu. A map of the front panel command structure is also included.

This chapter also contains information on how to configure the three remote interfaces that are provided on the back of the instrument.

Turning the Unit On

After you have connected the line cord, turn the unit on with the front panel power switch. The front panel display will light up after a few seconds.

A *power-on* self-test occurs automatically when you turn the unit on. This test assures you that the instrument is operational. If the self-test fails, the Err annunciator comes on. Press the Error key to display the list of errors on the front panel. Refer to Appendix D for further information.

When the front panel display appears, you can use the front panel controls to enter voltage and current values.

Selecting an Output Channel

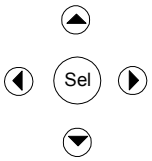
Channel

Press the Channel key to select the output channel that you wish to program.

Entering an Output Voltage Setting

Method 1 – Use the Navigation and Arrow Keys

Navigation Keys



Use the left and right navigation keys to navigate to the setting that you wish to change. In the display below, channel 1's voltage setting is selected. Enter a value using the numeric keypad. Then press Enter.

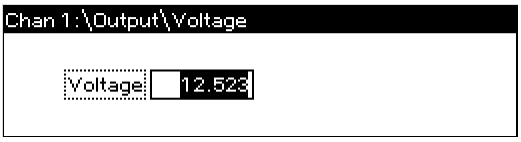
Arrow Keys

You can also use the arrow keys to adjust the value up or down. When the output is on and the unit is operating in CV mode, the output voltage changes immediately. Otherwise, the value will become effective when the output is turned on.

Method 2 - Use the Voltage key to enter a value

Voltage

Use the **Voltage** key to select the voltage entry field. In the display below, channel 1's voltage setting is selected. Enter the desired setting using the numeric keypad. Then press Enter.

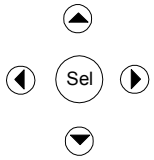


NOTE If you make a mistake, either use the ← backspace key to delete the number, press **Back** to back out of the menu, or press **Meter** to return to meter mode.

Entering a Current Limit Setting

Method 1 – Use the Navigation and Arrow Keys

Navigation Keys



Use the left and right navigation keys to navigate to the setting that you wish to change. In the display below, channel 1's current setting is selected. Enter a value using the numeric keypad. Then press Enter.

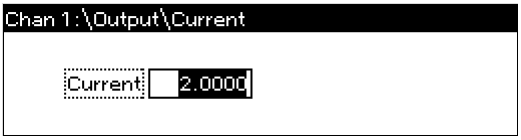
Arrow Keys

You can also use the arrow keys to adjust the value up or down. When the output is on and the unit is operating in CC mode, the output current changes immediately. Otherwise, the value will become effective when the output is turned on.

Method 2 - Use the Current key to enter a value

Current

Use the **Current** key to select the current entry field. In the display below, channel 1's voltage setting is selected. Enter the desired setting using the numeric keypad. Then press Enter.



NOTE If you make a mistake, either use the ← backspace key to delete the number, press **Back** to back out of the menu, or press **Meter** to return to meter mode.

Enabling the Output

Use the On/Off key to enable the output

On/Off

If a load is connected to the output, the front panel display will indicate that it is drawing current. Otherwise the current reading will be zero. The status indicator next to the channel number indicates the output's status. In this case, the output channel is in constant voltage mode.

NOTE For a complete description of the status indicators, refer to Chapter 6 under "STATus:OPERation:EVENt?" and "STATus:QUEStionable:EVENt?"

Using the Front Panel Menu

The front panel command menu lets you access most of the power system's functions. The actual function controls are located at the lowest menu level.

- Press the **Menu** key to access the command menu.
- Press the navigation keys to move across the menu commands.
- Press the center (**Sel**) key to select a command and move down to the next level in the menu.
- Press the **Help** key at the lowest menu level to display help information about the function controls.

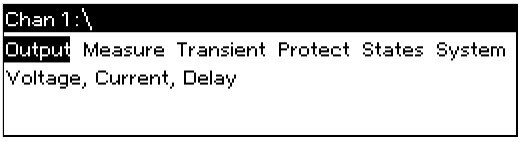
The following example shows you how to navigate the front panel command menu to program the over-voltage protection function.

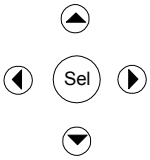
Set the Over-Voltage Protection

When over-voltage protection is enabled, the power system will turn off its output if the output voltage reaches the programmed over-voltage limit.

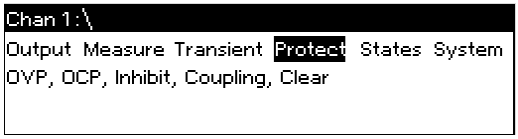
Menu

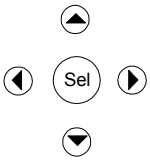
Press the **Menu** key to access the front panel command menu.
The first line identifies the output channel that is being controlled followed by the menu path. Since the top level is displayed, the path is empty.
The second line indicates the commands that are available at the present menu level. In this case the top-level menu commands are shown, with the Output command highlighted.
The third line indicates which commands are available under the Output command. The output command must be selected to access the next level.



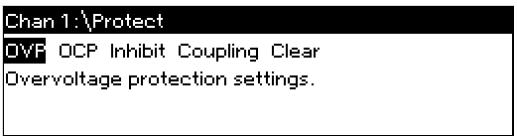


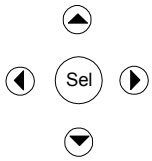
Press the right arrow ▶ navigation key to traverse the menu until the Protect command is highlighted. Press the **Sel** key to select the Protect command.





The menu path now shows that the commands shown on the second line are located under the Protect command. The OVP command is highlighted. The third line indicates which functions are located under the OVP command. Press the **Sel** key to select the OVP command.

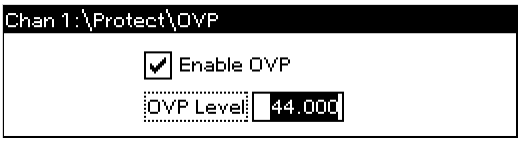




The command menu is now at the function control level. This is the lowest level in this path. Two over-voltage function controls are available.

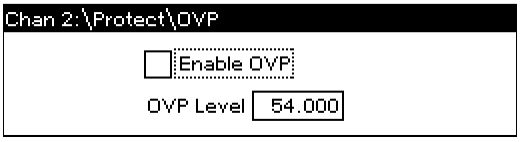
Use the navigation keys to highlight the Enable OVP control. This control enables or disables over-voltage protection. Pressing SEL or Enter will check or uncheck this control.

Use the navigation keys to highlight the OVP Level control as shown below. Enter the desired over-voltage level using the numeric keypad. Then press Enter.



Channel

Press the Channel key at any time to select a different output channel. This can save time because you can directly access the OVP control of each channel without having to navigate through the menu levels.



NOTE If you program an over-voltage protection level that is lower than the present output voltage, the over-voltage protection circuit will trip and turn the output channel off. The status indicator will show OV.

Exiting the Command Menu

There are two ways to exit the command menu.

- Press the **Meter** key to immediately return to the metering screen. This is the quickest way to return to metering mode.
- Press the **Back** key to back up one level at a time in the command menu. This method may be more convenient if there are other menu commands to be given.

Detailed instructions on how to use the power system's functions and capabilities are found in the next chapter. Detailed information about the SCPI programing commands are found in chapters 5 and 6.

In Case of Trouble

Press the **Help** key to obtain additional help about any function control menu level. Press the **Back** key to exit the Help menu.

If the self-test fails, or if other operating problems occur with your instrument the Err annunciator comes on. Press the **Error** key to display the list of errors. Refer to Appendix D for further information.

Front Panel Menu Commands

Menu Command				Control Description
Output	**Voltage**			Programs voltage setting and range.
	Current			Programs current setting and range.
	Delay			Program Turn-on /Turn Off delay.
Measure	**Range**			Selects voltage and current measurement range.
	Sweep			Specifies measurement points, time interval, and trigger offset.
	Window			Selects measurement window (Rectangular/Hanning).
	Control			Lets you abort a measurement in progress.
Transient	**Mode**	**Voltage**		Selects voltage mode (Fixed, Step, or List).
		Current		Selects current mode (Fixed, Step, or List).
	Step			Programs voltage and current steps. Enables step trigger signals.
	List	**Pace**		Specifies Dwell or Trigger paced list.
		Repeat		Specifies number of list repetitions, or specifies continuous list.
		Terminate		Specifies list settings when the list terminates.
		Config		Configures the list steps. Specify voltage, current, and dwell values. Also specifies trigger output signal states.
		Reset		Aborts the list and resets all list parameters.
	TrigSource			Specify the trigger source: bus, tran 1-4, pin 1-3.
	Control			Initiate, Trigger, or Abort output triggers.
Protect	**OVP**			Configures over-voltage protections function.
	OCP			Configures over-current protections function.
	Inhibit			Configures the external inhibit signal.
	Coupling			Disables ALL output channels when a protection fault occurs.
	Clear			Clears output protection.
State	**Reset**			Resets the instrument to its reset (*RST) state.
	Save/Recall			Saves or recalls an instrument state.
	PowerOn			Selects the power on state.
System	**Interface**	**LAN**	**Status**	Displays interface status information.
			IP	Enables/disables DHCP and Auto IP. Also sets the IP Address, Subnet Mask, and Default Gateway.
			DNS	Configures the DNS server.
			Name	Configures the Dynamic DNS and NetBIOS naming service.
			Domain	Configures the Domain Name.
			TCP	Configures the TCP keepalive function.
			Enable	Enables/disables the LAN interface and the built-in Web server.
		USB	**Status**	Displays status, speed, packets received, and packets sent.
			Identification	USB connect string - the instrument's unique USB identifier
			Enable	Enables/disables the USB interface.
		GPIB		Selects the GPIB address.
		Reset		Resets the interface settings to the factory-shipped state.

Menu Command				Control Description
System	**DigPort**	**Pin 1**	**Function**	Specifies the pin function: DigIO, TrigIn, TrigOut, DigIn, or FaultOut..
			Polarity	Specifies the pin polarity.
		Pin 2	**Function**	Specifies the pin function: DigIO, TrigIn, TrigOut, or DigIn.
			Polarity	Specifies the pin polarity.
		Pin 3	**Function**	Specifies the pin function: DigIO, TrigIn, TrigOut, DigIn, or InhibitIn.
			Polarity	Specifies the pin polarity.
		Data		Sends/reads data from the digital I/O port function
	Preferences	**Display**		Configures Screen saver, Wake-on I/O, and Display contrast.
		Keys		Enables/disables key clicks and configures the On/Off key.
		Security	**ResetNVRam**	Resets all non-volatile RAM settings to their factory defaults.
	Error			Displays the Error log.
	Calibrate	**State**		Enables/disables calibration. You must supply a password to enable.
		Sequence	**VProg**	**High** Enters measured data for high calibration point. **Low** Enters measured data for low calibration point.
			VMeas	Enters measured data.
			CMRR	Calibrates common mode rejection ratio.
			IProg	**High** Enters measured data for high calibration point. **Low** Enters measured data for low calibration point.
			IMeas	Enters Measured data.
			DPRog	Calibrates the downprogrammer.
			IPeak	Calibrates I peak.
		Date		Saves the calibration date for each channel.
		Save		Saves the calibration data.
		Password		Changes the password.
	About	**Frame**		Displays model, serial number, firmware revision, backup revision, and active firmware.
		Module		Displays model, serial number, options, voltage, current, and power.

Configuring the Interface

Once you have your power system up and running, you can configure the remote interface. The Agilent N6700 MPS supports GPIB, LAN, and USB interfaces. All three interfaces are live at power-on.

For detailed information about interface communication, refer to the Agilent Technologies *USB/LAN/GPIB Interfaces Connectivity Guide*, which you can download from the Agilent web site at http://www.agilent.com/find/connectivity.

CAUTION Electrostatic discharges greater than 1 kV near the interface connectors may cause the unit to reset and require operator intervention.

GPIB Interface

The following steps will help you quickly get started connecting your instrument to the General Purpose Interface Bus (GPIB):

1. If you do not have the Agilent I/O Library software installed on your PC, you can download the I/O library software from the Agilent web site at http://www.agilent.com/find/connectivity.
2. If you do not have a GPIB card installed in your PC, turn off your computer and install the GPIB interface card.
3. Connect your instrument to the GPIB card using a GPIB interface cable. Observe the following precautions:
   - The total number of devices including the GPIB interface card is no more than 15.
   - The total length of all cables used is no more than 2 meters times the number of devices connected together, up to a maximum of 20 meters.
   - Do not stack more than three connector blocks together on any GPIB connector.
   - Make sure all connectors are fully seated and the lock screws are firmly finger-tightened.
4. Set the power system's GPIB address. The power system is shipped with its GPIB address set to 5. Use the front panel menu if you need to change the GPIB address.
   a. To access the front panel menu, press the **Menu** key.
   b. To view the GPIB address, use the front panel navigation keys to select **System\Interface\GPIB**.
   c. To change the address, use the numeric keys to enter a new value. Valid addresses are from 0 to 30. Press the Enter key.
   d. To Exit out of the menu, press the **Meter** key.
5. Configure the GPIB interface card on your PC. Use **IO Config** to configure the installed GPIB interface card's parameters.
6. Use an application such as VISA Assistant to verify communications with instruments via the GPIB interface.

LAN Interface

The following steps will help you quickly get started connecting and configuring your LAN-enabled instrument.

1. If you do not have the Agilent I/O Library software installed on your PC, you can download the I/O library software from the Agilent web site at http://www.agilent.com/find/connectivity.
2. Connect your instrument to the LAN.
3. Configure your power system. As shipped from the factory, the power system's pre-configured settings will probably work in most LAN environments. If you need to manually configure these settings, you can do so using the instrument's front panel menu.
   a. Press the **Menu** key to access the front panel menu.
   b. To view the present LAN settings of the instrument, use the front panel navigation keys to select **System\Interface\LAN\ Status**.

NOTE These settings may be different from the requested settings - depending on your network configuration.

   c. To change the IP address of the instrument, use the front panel navigation keys to select **System\Interface\LAN\IP**. The following parameters can be configured:

Enable DHCP	Automatically assigns an IP address to the instrument provided it is connected to a network that supports DHCP.
Enable AutoIP	Automatically assigns an IP address to the instrument if it is on a network that does not have a DHCP server.
IP Address	If enable DHCP and Enable AutoIP are turned off, you must manually enter your IP address in this field. Contact your network administrator for the IP address to use.
Subnet Mask	Lets you manually enter the subnet mask. Ask your network administrator if a subnet mask is needed, and for the correct mask.
Default Gateway	Lets you manually enter the default gateway. The gateway is a device that connects two networks. Ask your network administrator if a gateway is in use, and for the correct address.

   d. To configure the DNS setup of the instrument, select the following menu commands: **System\Interface\LAN\DNS**. The following parameters can be configured:

Obtain DNS server from DHCP — Automatically gets the address of the DNS server on your network if you have enabled DHCP in the IP menu.

Use the following DNS server — Select this item if you are not using DHCP or need to connect to a specific DNS server.

DNS server — Lets you manually enter the address of the DNS server. Contact your network administrator for the server address to use.

e The instrument is shipped with a unique host name. If you want to change the host name, you should do so before you connect the instrument to the network. Otherwise, the original host name may be cached in the network for up to several hours. To change the Host name, select: **System\Interface\LAN\Name**. The following parameters can be configured:

Host name — Enter a Host name for your instrument in this field. The Host name is the host portion of the domain name, which is translated into an IP address. Use the navigation keys to enter an alpha character. Use the up/down navigation or arrow keys to select a letter from the alphabetic choices as you scroll through the selections. Use the number keys to enter a number.

Use Dynamic DNS naming service — Registers the Host name using the Dynamic DNS naming system.

Use NetBIOS naming service — Registers the Host name using the NetBIOS naming protocol.

f Some dynamic DNS servers require an instrument to register not only the Host name, but also the domain name. To set the Domain name, select: **System\Interface\LAN\Domain**.

Domain name — Enter a Domain name for your instrument in this field. The Domain name is translated into an IP address. Use the navigation keys to enter an alpha character. Use the up/down navigation or arrow keys to select a letter from the alphabetic choices as you scroll through the selections. Use the number keys to enter a number.

g To configure the TCP settings, select the following menu commands: **System\Interface\LAN\TCP**. The following parameters can be configured:

Enable TCP keepalive — Keeps a LAN socket active for the specified number of seconds. This is useful to determine if a client is still reachable. If there has been no activity on the connection after the specified time, the instrument will send keepalive probes to the client to determine if it is still alive. After the specified time-out, the connection will be marked as down or dropped. The instrument releases resources that were allocated to the client.

TCP keepalive timeout — Enter the number of seconds to keep a LAN socket active.

h To enable or disable the LAN as well as the built-in Web server on your instrument, select the following menu commands: **System\Interface\LAN\Enable**.

Enable LAN — This is enabled when shipped. To disable the LAN, simply uncheck this box.

Enable Web Server — This is enabled when shipped. It lets you control the instrument directly from the internet browser on your computer. Provided that you have correctly configured the previously discussed LAN settings, simply type the instrument's Host name or IP address in your browser to launch the application.

i To exit out of the menu, press the **Meter** key.

4 Use **IO Config** to configure the TCP/IP LAN Client interface. Then add your instrument identifiers to the interface software.

5 Use an application such as VISA Assistant or the Telnet utility to verify communications with instruments via the LAN.

USB Interface

The following steps will help you quickly get started connecting your USB-enabled instrument to the Universal Serial Bus (USB):

1 If you do not have the Agilent I/O Library software installed on your PC, you can download the I/O library software from the Agilent web site at http://www.agilent.com/find/connectivity.

2 Connect your instrument to the USB port on your PC.

3 The USB interface requires no front panel configuration other than enabling or disabling it. To view the instrument's USB connect string, use the navigation keys to select the following menu commands: **System\Interface\USB\Identification**. The **Status** command lets you view status information about the interface when it is in use.

4 To enable or disable the USB interface, select the following menu commands: **System\Interface\USB\Enable**.

Enable USB — This is enabled when shipped. To disable the USB, simply uncheck this box.

5 You can set or change the instrument's USB Alias name from the **Edit Config** dialog box on your PC. You can also do this later using **IO Config**.

6 You can also use **IO Config** to display the USB Devices dialog box. From this box you can check instrument identification parameters.

7 Use an application such as VISA Assistant to verify communications with instruments via the USB interface.

Remote Interface and Other Non-volatile Factory Settings

Remote interface settings are stored in non-volatile memory. The following table documents the the factory-shipped non-volatile settings. The interface settings can be restored by selecting the Reset control located in the **System\Interface** menu. **All** non-volatile settings can be restored by selecting the ResetNVRam control located in the **System\Preferences\Security\ResetNVRam** menu.

Factory-shipped non-volatile interface settings (can be resorted with either Reset or ResetNVRam control)			
GPIB Address	5	Use DNS naming service	Enabled
DHCP	Enabled	Use NetBIOS naming service	Enabled
AutoIP	Enabled	Domain Name	Blank
IP Address	127.0.0.1	TCP keepalive	Enabled
Subnet Mask	255.255.255.0	TCP keepalive seconds	1800
Default Gateway	Blank	Web server	Enabled
Obtain DNS server from DHCP	Enabled	LAN	Enabled
DNS server	Blank	USB	Enabled
Host name	A-N6700A-xxxxx		
Other factory-shipped non-volatile settings (can be restored with the ResetNVRam control)			
Digital port function (all pins)	Digital In	Wake on I/O	Enabled
Digital port polarity (all pins)	Positive	Screen contrast	50%
Key clicks	Enabled	Calibration date	March 5, 2003
On/Off key affects all channels	Disabled	Calibration password	0
Screen saver	Enabled	Output Inhibit mode	Off
Screen saver delay	60 minutes	Saved states	*RST command

The factory-shipped interface settings described above are optimized for connecting your power system to a site network. They will also work well for other network configurations. However, if your power system is connected either to an isolated subnet, or a private LAN (directly connected to a PC), the following configuration changes are recommended for improved performance:

When connected to an isolated subnet: In the **System\Interface\LAN\DNS** dialog box, select **Use the following DNS server**. However, leave the **DNS server** address field blank.

When connected to a private LAN: In the **System\Interface\LAN\IP** dialog box, turn off **Enable DHCP**. Turning DHCP off will reduce the time that the power system requires when it is turned on to fully configure a network connection. This normally takes several minutes.

4
Operating the Power System

Programming the Output 40

Synchronizing Output Steps 42

Making Measurements 45

System Related Operations 46

Programming High-Speed Test Extensions 49

This chapter contains examples on how to operate your power system from the front panel and over the remote interface using SCPI commands. Refer to chapters 5 and 6 for more information on programming your power system using SCPI commands.

The simple examples discussed in this chapter show you how to program:

- output voltage and current functions
- protection functions
- internal and external triggers
- measurement functions
- system functions

NOTE This chapter shows what front panel menu controls as well as what SCPI commands are used to perform a particular function. Programming examples in the Visual BASIC programming environment are provided in chapter 7.

Programming the Output

Set the Output Voltage

Front Panel:	SCPI Command:

Press the Channel key to select an output, then press the Voltage key.
Enter a value and press Select.
	To set output 1 to 5 V:
	`VOLT 5,(@1)`
	To set all outputs to 10 V:
	`VOLT 10,(@1:4)`

For modules with multiple ranges, you can select a lower range if you need better output resolution.

Front Panel:	SCPI Command:
Press the Channel key to select an output, then press the Voltage key. Select Low range and press Select.	To select the lower range, program a value that falls within the range: `VOLT:RANG 5,(@1)`

Set the Output Current

Front Panel:	SCPI Command:

Press the Channel key to select an output, then press the Current key.
Enter a value and press Select.
	To set output 1 to 1 A:
	`CURR 1,(@1)`
	To set all outputs to 2 A:
	`CURR 2,(@1:4)`

For modules with multiple ranges, you can select a lower range if you need better output resolution.

Front Panel:	SCPI Command:
Press the Channel key to select an output, then press the Voltage key. Select Low range and press Select.	To select the lower range, program a value that falls within the range: `CURR:RANG 1,(@1)`

Enable the Output

Front Panel:	SCPI Command:

To enable one output, press the Channel key to select the output, then press the On/Off key.
To enable/disable ALL outputs with the On/Off key, select **System\Preference\Keys**. Check the On/Off couple dialog box.
The ON/Off key will now be active on ALL output channels.
	To enable only output 1:
	`OUTP ON,(@1)`
	To enable outputs 1-4:
	`OUTP ON,(@1:4)`

Because of internal circuit start-up procedures and any installed relay options, the output on command may take between 35 and 50 milliseconds to complete its function. Conversely, the output off command may take between 20 and 25 milliseconds to complete its function.

If you need to mitigate this built-in delay, you can program the output to zero volts rather than using the output on/off command.

Sequence Multiple Outputs

You can specify a turn-on and turn-off delay to control the power-up and power-down sequencing of the output channels.

Front Panel:	SCPI Command:

Press the Channel key to select an output. Select the **Output\Delay**.
Select either Turn-on or Turn-off. Enter a delay in seconds, then press Select.
	To program a 50 millisecond turn-on delay for output 1 and a 100 millisecond turn-on delay for output 2:
	`OUTP:DEL:RISE .05,(@1)`
	`OUTP:DEL:RISE .1,(@2)`
	To turn on outputs 1 and 2:
	`OUTP ON,(@1,2)`
	To program a 200 millisecond turn-off delay for outputs 3 and 4:
	`OUTP:DEL:FALL .2,(@3,4)`
	To turn off outputs 3 and 4:
	`OUTP OFF,(@3,4)`

Set the Over-Voltage Protection

When over-voltage protection is enabled, the power system will turn off its output if the output voltage reaches the over-voltage limit.

Front Panel:	SCPI Command:

Select **Protect\OVP**.
Check the OVP enable box and press Select.
Enter a value in the OVP level box and press Select.
	To set the OVP level for outputs 1 and 2 to 10 V:
	`VOLT:PROT 10,(@1,2)`
	To enable OVP for output 1 and 2:
	`VOLT:PROT:STAT 1,(@1,2)`

Set the Over-Current Protection

When over-current protection is enabled, the power system will turn off its output if the output current reaches the current limit setting.

Front Panel:	SCPI Command:
Select **Protect\OCP**. Check the OCP enable box and press Select.	To enable OCP for output 1 and 2: `CURR:PROT:STAT 1,(@1,2)`

Clear Output Protection Functions

If an over-voltage, over-current, over-temperature, inhibit signal, or a power-fail condition occurs, the power system turns off the affected output channel. The PROT annunciator on the front panel will be on. To clear the protection function and restore normal operation, first remove that condition that caused the protection fault.

Then, clear the protection function as follows:

Front Panel:	SCPI Command:
Select **Protect\Clear**. Select the Clear button.	To clear a protection fault on output1: `OUTP:PROT:CLE(@1)`

Synchronizing Output Steps

The transient system lets you step the output voltage and current up or down in response to triggered events. To generate a triggered output step you must:

1. Enable the output to respond to trigger commands.
2. Set the voltage or current trigger levels.
3. Select the transient trigger source.
4. Initiate the trigger system and provide a trigger signal.

Enable the Output to Respond to Trigger Commands

First, you must enable the output to respond to trigger commands. Unless an output is enabled to respond to triggers, nothing will happen even if you have programmed a trigger level and generated a trigger for the output. Use the following commands to enable an output to respond to triggers:

Front Panel:	SCPI Command:

To enable voltage Step triggering select **Transient\Mode\Voltage**.
Select Step and press Select.
To enable current Step triggering select **Transient\Mode\Current**.
Select Step and press Select.
	To enable the voltage function on output 1 to respond to triggers, use:
	`VOLT:MODE STEP,(@1)`
	To enable the current function on output 1 to respond to triggers, use:
	`CURR:MODE STEP,(@1)`

NOTE In Step mode, the triggered value becomes the immediate value when the trigger is received. In Fixed mode, trigger signals are ignored; the immediate values remain in effect when a trigger is received.

Set the Voltage or Current Trigger Levels

Next, use the following commands to program an output trigger level. The output will go to this level when the trigger is received.

If you have a model that has multiple ranges, the selected triggered voltage and current settings must be within the **same** range that the output channel is presently operating in.

Front Panel:	SCPI Command:

Select **Transient\Step**. Then select the Trig Voltage box. Enter a value and press Select.
Select the Trig Current box to set current. Enter a value and press Select.
	To set a voltage and current trigger level for output 1 use:
	`VOLT:TRIG 15,(@1)`
	`CURR:TRIG 1,(@1)`

Select the Transient Trigger Source

NOTE An immediate trigger command from either the front panel or over the bus will generate an immediate trigger regardless of the trigger source.

Unless you are using the front panel menu or a TRIG:TRAN command to trigger the output, select a trigger source from the following:

Bus Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).

Pin <number> Selects a pin on the external port connector as the trigger source. You can specify pins 1, 2, or 3. The selected pin must be configured as a Trigger Input in order to be used as a trigger source (see Appendix C)

Transient <channel> Selects the output channel's transient system as the trigger source. <channel> specifies the channel.

When you select a channel, you must also set up that channel's transient system to generate a trigger out signal. Refer to "Generating a Transient Trigger Signal".

Use the following commands to select a trigger source:

Front Panel:	SCPI Command:

To select Bus triggers, select **Transient\TrigSource**. Then select Bus.
To select Digital pin triggers, select **Transient\TrigSource**. Then select one of the digital port pins.
To select Transient output triggers, select **Transient\TrigSource**. Then select one of the output channels.
	To select Bus triggers for output 1:
	`TRIG:SOUR BUS,(@1)`
	To select Digital pin triggers:
	`TRIG:SOUR PIN<n>,(@1)`
	where n is the pin number.
	To select Transient output triggers:
	`TRIG:SOUR TRAN<n>,(@1)`
	where n is the output channel that will generate the trigger signal.

Initiate the Transient Trigger System

Next, you must initiate or enable the transient trigger system.

When the power system is turned on, the trigger system is in the idle state. In this state, the trigger system is disabled, ignoring all triggers. Initiating the trigger system moves it from the idle state to the initiated state, which enables the power system to receive triggers. To initiate the trigger system, use:

Front Panel:	SCPI Command:
Select the **Transient\Control**. Scroll to Initiate and press Select.	To initiate the output trigger system for all four outputs: `INIT:TRAN (@1:4)`

After a trigger is received and the action completes, the trigger system returns to the idle state. Thus it will be necessary to enable the system each time a triggered action is desired.

Trigger the Output

The trigger system is waiting for a trigger signal in the initiated state. You can immediately trigger the output as follows:

Front Panel:	SCPI Command:
Select **Transient\Control**. Select Trigger to generate an immediate trigger signal regardless of the trigger source setting.	To generate an immediate trigger on channel 1: `TRIG:TRAN (@1)` Alternatively, if the trigger source is BUS, you can also program a `*TRG` or an IEEE-488 <get> command

When a trigger is received, the triggered functions are set to their programmed trigger levels. When the triggered actions are completed, the trigger system returns to the idle state.

As previously discussed, a trigger can also be generated by another output channel or by a trigger signal applied to an input pin on the digital port connector. If any of these systems are configured as the trigger source, the instrument will wait indefinitely for the trigger signal. If the trigger does not occur, you must manually return the trigger system to the idle state.

The following commands return the trigger system to the idle state:

Front Panel:	SCPI Command:
Select the **Transient\Control**. Scroll to and select Abort.	`ABOR`

Generating Trigger Out Signals

Each output channel can generate trigger signals that can be used by other output channels, or routed to a pin on the digital port that has been configured as a trigger output (TOUT). Use the following commands to program transient trigger signals that are generated when an output Step occurs:

Front Panel:	SCPI Command:
Use the Channel key to select the channel that is the trigger source. Select **Transient\Step**. Check Enable Trigger Output. Then press Select.	To program channel 3's step function to generate a trigger signal, use `STEP:TOUT ON,(@3)`

Making Measurements

Each output channel has its own measurement capability. The output voltage and current is measured by acquiring a number of samples at the selected time interval, applying a window function to the samples, and *averaging* the samples.

The power-on and *RST time interval and number of samples settings yield a measurement time of 21 milliseconds per reading (1024 data points at 20.48 µs intervals). The windowing function is Rectangular. Use the following commands to make a measurement:

Front Panel:	SCPI Command:

Select the Meter key.	To measure the average output voltage or current, use:
	`MEAS:VOLT?(@1:4)`
	`MEAS:CURR?(@1:4)`

Simultaneous Voltage and Current Measurements

Some models have simultaneous voltage and current measurement capability. Refer to Chapter 1, "Model Differences" for model-specific information.

In this case BOTH voltage and current are acquired on any measurement, regardless of the parameter that is being measured. To return both values of a simultaneous measurement:

Front Panel:	SCPI Command:

Not available.	First, measure either the output voltage (or current):
	`MEAS:VOLT?(@1:4)`
	Then Fetch the other parameter:
	`FETC:CURR?(@1:4)`

Measurement Ranges

Some models have two voltage and current measurement ranges. Refer to Chapter 1, “Model Differences” for model-specific information. Selecting a lower measurement range provides greater measurement accuracy, provided that the measurment does not exceed the range. The commands that control the ranges are:

Front Panel:	SCPI Command:
Select **Measure\Range**. Select the desired voltage or current range and press Select.	`SENS:CURR:RANG 0.1, (@1)` `SENS:VOLT:RANG 5, (@1)`

When the range is set to MAX, the maximum current that can be measured is the maximum rating of the unit. Two examples of programming measurement ranges are:

0.1 A range To select, program values ≤ 0.1A.

3 A range To select, program values > 0.1A and ≤ 3A.

System Related Operations

Self-Test

A *power-on* self-test occurs automatically when you turn on the power system. This test assures you that the instrument is operational. If the self-test is successful, the power system will continue to operate normally. If the self-test fails, the Err annunciator comes on. Press the Error key to display the list of errors on the front panel. Refer to Appendix D for further information.

Front Panel:	SCPI Command:
Cycle power.	`*TST?`

Instrument Identification

For Agilent N6700A mainframes, you can return the model number, serial number, firmware revision, backup firmware, active firmware. For Agilent N67xxA power modules, you can return the model number, serial number, installed options, voltage rating, current rating, and power rating.

Front Panel:	SCPI Command:

Select **System\About\Frame**.
or
Select **System\About\Module**.
	`*IDN?`
	`SYST:CHAN:MOD? (@1)`
	`SYST:CHAN:OPT? (@1)`
	`SYST:CHAN:SER? (@1)`

Instrument State Storage

The power system has two storage locations in non-volatile memory to store instrument states. The locations are numbered 0 and 1. Any state previously stored in the same location will be overwritten.

Front Panel:	SCPI Command:

Select **States\SaveRecall**.
In the SaveRecall field, enter a location from 0 to 1, and press Select. Select Save to save the state or Recall to recall a state .
	To save a state:
	`*SAV <n>`
	To recall a state:
	`*RCL <n>`

When shipped from the factory, the power system is configured to automatically recall the reset (*RST) settings at power-on. However, you can configure the power system to use the settings stored in memory location 0 at power-on.

Front Panel:	SCPI Command:
Select **States\PowerOn**. Select Recall State 0, then press Select.	`OUTP:PON:STAT RCL0`

Front Panel Lockout

You can disable the front panel keys to prevent unwanted control of the instrument from the front panel. This can only be done through the following SCPI command.

Front Panel:	SCPI Command:
Not available.	`SYST:COMM:RLST RWLock`

Front Panel Screen Saver

As shipped from the factory, the power system has a front panel screen saver that is set to come on one hour after activity on the front panel or interface has ceased. The screen saver function significantly increases the life of the LCD display by turning it off during periods of inactivity.

When the screen saver is active, the front panel display turns off and the LED next to the Line switch changes from green to amber.

To restore the front panel display, simply press one of the front panel keys. The first action of the key turns the display on. Subsequently, the key will revert to its normal function.

If the Wake on I/O menu function is selected, the display will be restored on any time an I/O command is sent to the instrument. Additionally, any interface activity also resets the timer on the screen saver. As shipped, the Wake on I/O menu function is active.

Front Panel:	SCPI Command:
Select **System\Preferences\Display** Enable or disable the screen saver by checking the Screen Saver checkbox. Then Press Select. Enter a value in minutes in the Saver Delay field to specify the time when the screen saver will activate. Check Wake on I/O to activate the display with I/O bus activity.	Not Available.

Front Panel Contrast

You can set the contrast of the front panel display to compensate for ambient lighting conditions. The contrast can be set from 0% to 100% in increments of 1%. As-shipped, the contrast is set to 50%.

Front Panel:	SCPI Command:
Select **System\Preferences\Display** Enter a contrast value in the Contrast box. Then Press Select.	Not available.

Built-In Web Server

The power system contains a built-in Web server that lets you control the instrument directly from an internet browser on your computer.

NOTE This feature requires Internet Explorer 5+ or Netscape 6.2+. Your PC must also have the ability to communicate over a LAN.

The Web Server function is enabled when shipped. Provided that you have correctly configured the instrument's LAN settings as discussed in chapter 2, simply type the instrument's Host name or IP address into your browser to launch the application.

Front Panel:	SCPI Command:
Select **System\Interface\LAN\Web** To enable the Web server, check the Enable Web Server checkbox.	Not Available.

Programming High-Speed Test Extensions

NOTE The High-Speed Test Extensions described in this section are not available on all models. Refer to Chapter 1, "Model Differences" for model-specific information.

The List Function

Either output voltage or output current, or both together, may be list-controlled. List mode lets you generate complex sequences of output changes with rapid, precise timing, which may be synchronized with internal or external signals. Lists can contain up to 512 individually programmed steps and can be programmed to repeat themselves.

The voltage and current lists are paced by a separate list that defines the duration or dwell of each step. Each of the up to 512 steps can have an individual dwell time associated with it, which specifies the time in seconds that the list will remain at that step before moving on to the next step.

If you need an output list to closely follow external events, then a trigger-paced list is more appropriate. In a trigger-paced list, the list advances one step for each trigger received. As previously discussed, a number of trigger sources can be selected to generate triggers. With a trigger-paced list, you do not need to program a dwell time for each step. If you do program a dwell time, triggers that are received during the dwell period are ignored. The default dwell time is 0.001 seconds.

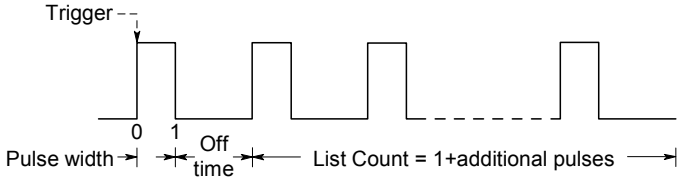
Voltage and current lists can also be configured to generate trigger signals at specified steps. This is accomplished by two additional lists: a beginning-of-step (BOST) and an end-of-step (EOST) list. These lists define which steps will generate a trigger signal and if the trigger occurs at the beginning or end of the step. These trigger signals can be used to synchronize other events with the list.

When either a voltage or current list is programmed, the associated dwell, BOST, and EOST lists must all be set to the same number of steps, otherwise an error will occur when the list is run. For convenience, a list may be programmed with only one step or value. In this case a single-step list is treated as if it had the same number of steps as the other lists, with all values being equal to the one value.

NOTE List data is not stored in non-volatile memory. This means that list data that is sent to the instrument either from the front panel or over the bus will be lost when the power system is turned off.

Program an Output Pulse or Pulse Train

The following procedure shows how to generate an output pulse train using the List function.



Step 1. Set the voltage or current function for which you want to generate a pulse to List mode. This example programs a voltage pulse.

Front Panel:	SCPI Command:
Select **Transient\Volt\Mode**. Scroll to List and press Select.	To program output 1, use `VOLT:MODE LIST, (@1)`

Step 2. Set the amplitude and width of the pulse. For example, to generate a pulse with an amplitude of 15 V and a pulse width of 1 second, use:

Front Panel:	SCPI Command:

Select **Transient\List\Config**.
Select List Step 0 and enter a voltage value of 15. Press Select.
Enter a dwell value of 1 for List Step 0 and Press Select.
	To program output 1, use
	`LIST:VOLT 15, (@1)`
	`LIST:DWEL 1, (@1)`

Step 3. Set the list pacing to Auto, so that as each dwell time elapses, the next step is immediately output.

Front Panel:	SCPI Command:
Select **Transient\List\Pace**. Select Dwell and press Select.	`LIST:STEP AUTO, (@1)`

If you only wish to program a single pulse, skip steps 4 and 5 and go to step 6.

Step 4. If you want to generate a pulse train, you must specify the off time between pulses. To do this you must program another step. For a voltage list, you must specify an amplitude and an off time. For example, to program an off time of 2 seconds with an amplitude of 0 V between pulses, use:

Front Panel:	SCPI Command:

Select **Transient\List\Config**.
Select List Step 1 and enter a voltage value of 0. Press Select.
Enter a dwell value of 2 for List Step 1 and Press Select.
	To program output 1, use
	`LIST:VOLT 15,0, (@1)`
	`LIST:DWEL 1,2, (@1)`

Step 5. To generate a pulse train, you can simply repeat the pulse as needed. For example, to program a pulse train of 50 pulses, use:

Front Panel:	SCPI Command:
Select **Transient\List\Repeat**. Enter the number of list repetitions (50) and Press Select.	To program output 1, use `LIST:COUN 50, (@1)`

Step 6. Specify if you want the output pulse to generate a trigger signal that can be used to trigger actions on other output channels or on any external equipment connected to the digital port. For example, to generate a trigger signal at the end of the pulse, use:

Front Panel:	SCPI Command:
Select **Transient\List\Config**. Select List Step 0 and check the Tout Step box. Press Select.	To program a trigger at the End of the pulse for output 1, use `LIST:TOUT:EOST 1,0, (@1)` You must program a value of 0 (no trigger) for step 1 as a placeholder.

Step 7. Specify the output state after the pulse has completed. For example, to return the output to the state it was in before the pulse, use:

Front Panel:	SCPI Command:
Select **Transient\List\Terminate**. Select Return to Start. Press Select.	To program the output 1, use `LIST:TERM 0, (@1)`

Step 8. Select the trigger source that will generate the pulse or pulse train. For example, to select Bus triggers as the trigger source, use:

Front Panel:	SCPI Command:
Select **Transient\TrigSource**. Select Bus and press Select.	To program output 1, use: `TRIG:SOUR BUS, (@1)`

Step 9. Initiate the output trigger system. To enable the trigger system for one transient event or trigger use:

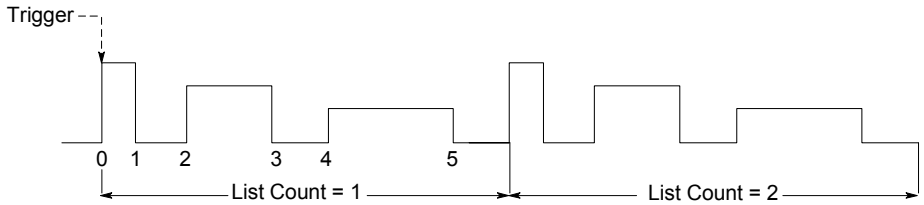
Front Panel:	SCPI Command:
Select the **Transient\Control**. Select Initiate and Press Select.	To program output 1, use `INIT:TRAN, (@1)`

Step 10. Trigger the output pulse or pulse train.

Front Panel:	SCPI Command:
Select **Transient\Control**. Select Trigger and Press Select.	`*TRG`

Program an Arbitrary List

The following procedure shows how to generate the list of voltage changes as illustrated in the following figure.



Step 1. Set the function, voltage or current, for which you want to generate a list to List mode. This example programs a voltage list.

Front Panel:	SCPI Command:
Select **Transient\Mode\Volt**. Scroll to List and press Select.	To program output 1, use `VOLT:MODE LIST, (@1)`

Step 2. Program the list of values for the List function. The order in which the values are entered determines the order in which the values will be output. To generate the voltage list shown in the figure, a list may include the following values: `9, 0, 6, 0, 3, 0`

Front Panel:	SCPI Command:
Select **Transient\List\Config**. Select the List Step number and enter a voltage value. Press Select. Repeat this for each step. Use the ⬆ ⬇ keys to select the next step.	To program output 1, use `LIST:VOLT 9,0,6,0,3,0, (@1)`

Step 3. Determine the time interval, in seconds, that the output remains at each step in the list before it advances to the next step. To specify the six dwell intervals in the figure, a list may include the following values: `2, 3, 5, 3, 7, 3`

Front Panel:	SCPI Command:
Select **Transient\List\Config**. Select the List Step number and enter a dwell value. Press Select. Repeat this for each step. Use the ⬆ ⬇ keys to select the next step.	To program output 1, use `LIST:DWEL 2,3,5,3,7,3, (@1)`

NOTE The number of dwell steps must equal the number of voltage steps. If a dwell list has only one value, that value will be applied to all steps in the list.

Step 4. Determine how the list is paced. To pace the list by dwell time, set the list pacing to Dwell-paced on the front panel menu. (Set the LIST:STEP command to AUTO.) As each dwell time elapses, the next step is immediately output.

Front Panel:	SCPI Command:
Select **Transient\List\Pace**. Select Dwell-paced. Press Select.	`LIST:STEP AUTO, (@1)`

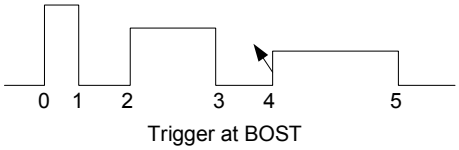
In a trigger-paced list, the list advances one step for each trigger received. To enable trigger-paced lists, select Trigger-paced on the front panel menu. (Set the LIST:STEP command to ONCE.)

The dwell time associated with each step determines the minimum time that the output remains at the step. If a trigger is received before the dwell time completes, the trigger is ignored. To ensure that no triggers are lost in a trigger-paced list, set the dwell time to zero.

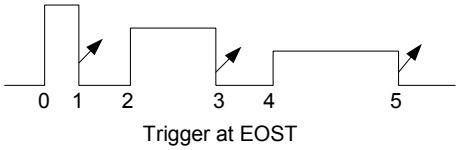
Step 5. Specify if you want the list to generate trigger signals that can be used to trigger actions on other output channels or on external equipment connected to the digital port.

Front Panel:	SCPI Command:

Select **Transient\List\Config**.
Select the List Step number.
To generate a trigger, enter a 1 in the Tout Begin Step or Tout End Step field. If a zero is entered, no trigger is generated for the step.
Repeat this for each step. Use the ⬆ ⬇ keys to select the next step.
	To program a trigger at the beginning of step 4 for output 1, use
	`LIST:TOUT:BOST 0,0,0,0,1,0, @(1)`
	To program a trigger at the end of step 0, 2, and 4 for output 1, use
	`LIST:TOUT:EOST 1,0,1,0,1,0, (@1)`



Trigger at BOST



Trigger at EOST

Step 6. Specify how you want the list to terminate.

Front Panel:	SCPI Command:
Select **Transient\List\Terminate**. Select Stop Last Step. Press Select.	To program the output 1 list to remain at the last list step when finished, use `LIST:TERM 1, (@1)`

Step 7. If applicable, specify how many times you want the list to repeat. Sending the INFinity parameter in the SCPI command makes the list repeat indefinitely. At reset, the list count is set to 1.

Front Panel:	SCPI Command:
Select the **Transient\List\Count**. Enter a value in the Count field and press Select.	To program the output 1 list to repeat 2 times, use `LIST:COUN 2, (@1)`

Step 8. Select a trigger source, initiate, and trigger the list. This is described in detail under "Synchronizing Output Steps".

The Digitizer Function

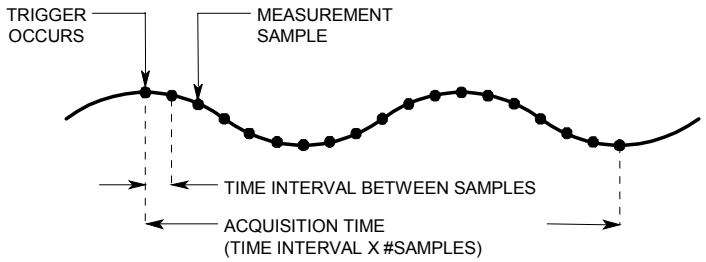
The digitizer function lets you access the enhanced voltage and current measurement capabilities of the power system. These include:

- Adjusting the measurement sample rate - to a maximum of 50 kHz.
- Adjusting measurement triggers to capture pre-trigger transients.
- Selecting a measurement window that can attenuate ac noise.
- Retrieving arrays that contain the digitized output current or output voltage.
- Synchronizing measurements with either a Bus, Transient, or external trigger.

Programming the Digitizer

Adjust the Measurement Sample Rate

The following figure illustrates the relationship between measurement samples (or points), and the time interval between samples in a typical measurement.



Ripple rejection is a function of the number of cycles of the ripple frequency contained in the acquisition window. More cycles in the acquisition window results in better ripple rejection. You can vary the measurement data sampling rate using the following commands:

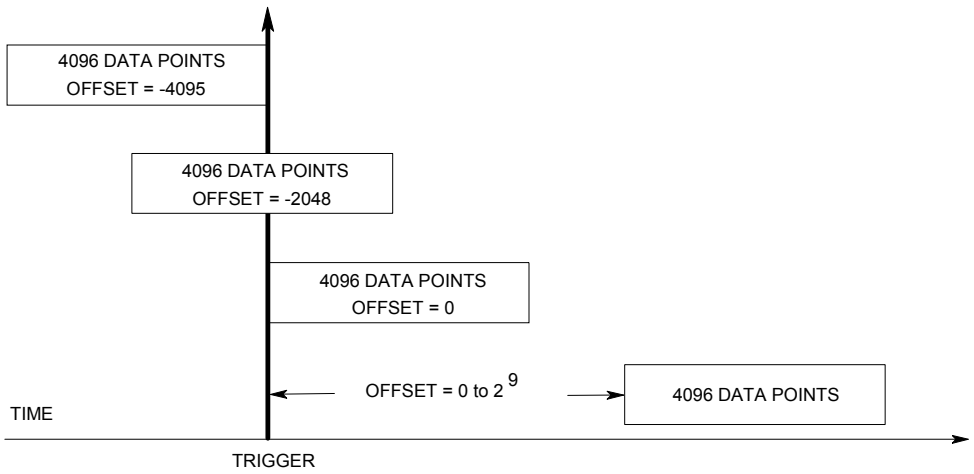
Front Panel:	SCPI Command:

Select **Measure\Sweep\Points**. Enter a value and press Select.
Then scroll to Time Interval, enter a value and press Select again.
	For example, to set the time interval to 60µs* with 4096 samples, use:
	`SENS:SWE:TINT 60E-6, (@1)`
	`SENS:SWE:POIN 4096, (@1)`

*The time interval is rounded to the nearest 20.48µs interval, which is 61.44µs.

Acquire Pre-trigger Data

The measurement system lets you capture data before, after, or at the trigger signal. As shown in the following figure, you can move the block of data being read into the acquisition buffer with reference to the trigger. This allows pre- or post-trigger data sampling.



To offset the beginning of the acquisition buffer relative to the acquisition trigger, use:

Front Panel:	SCPI Command:
Select **Measure\Sweep\Offset**. Enter an offset value and press Select.	To offset the measurement on channel 1 by 100 points use: `SENS:SWE:OFFS:POIN 100,(@1)`

With a negative offset, values at the beginning of the buffer represent samples taken prior to the trigger. When the value is 0, all values are taken after the trigger. Values greater than 0 can be used to program a delay time from the receipt of the trigger until the values entered into the buffer are valid. (Delay time = offset x sample period).

NOTE If, during a pre-trigger data acquisition, a trigger occurs before the pre-trigger data count is completed, the measurement system ignores this trigger. This will prevent the completion of the measurement if another trigger is not generated.

Specify a Window Function

Windowing is a signal conditioning process that reduces the error in average measurements made in the presence of periodic signals and noise. Two window functions are available: Rectangular and Hanning. At power-on, the measurement window is Rectangular.

The Rectangular window calculates average measurements without any signal conditioning. However, in the presence of periodic signals such ac line ripple, a Rectangular window can introduce errors when calculating average measurements. This can occur when a non-integral number of cycles of data has been acquired due to the last partial cycle of acquired data.

One way of dealing with AC line ripple is to use a Hanning window. The Hanning window applies a $\cos^4$ weighting function to the data when calculating average measurements. This attenuates the AC noise in the measurement window. The best attenuation is achieved when at least three or more waveform cycles are in the measurement.

To select a window function, use:

Front Panel:	SCPI Command:
Select Measure\Window. Then select either Rectangular or Hanning and press Select.	To set the sense window to Hanning for output 1 use: `SENS:WIND HANN, (@1)`

Retrieve Measurement Array Data

Array queries return all values in the voltage and current measurement buffer. No averaging is applied, only raw data is returned from the buffer. The following commands initiate and trigger a measurement and return the measurment array:

Front Panel:	SCPI Command:
Not Available	`MEAS:ARR:VOLT? (@1:4)` `MEAS:ARR:CURR? (@1:4)`

Once a measurement finishes, you may wish to retrieve the array data without initiating a new measurement. Use FETCh queries to return the array data from the last meausrement.. Fetch queries do not alter the data in the measurement buffer. The commands are:

Front Panel:	SCPI Command:
Not Available	`FETC:ARR:VOLT? (@1:4)` `FETC:ARR:CURR? (@1:4)`

If a FETCh query is sent before the measurement is started or before it is finished, the response will be delayed until the measurement trigger occurs and the acquisition completes. This may tie up the computer if the measurement trigger does not occur immediately.

Synchronizing Digitizer Measurements

Use the measurement trigger system to synchronize the acquisition of measurements with either a Bus, Transient, or an external trigger. Then use FETCh commands to return voltage or current information from the acquired data. Briefly, to make a triggered measurement:

1. Select the measurement function to trigger.
2. Select the trigger source.
3. Initiate the trigger system and generate a trigger.
4. Fetch the triggered measurements.

Select the Measurement Function to Trigger

Some models have two measurement converters, which allows simultaneous voltage and current measurements (refer to Chapter 1, “Model Differences”). If a model has only one converter and a triggered measurement is initiated, the parameter that it measures (either voltage or current) must be specified.

To trigger measurements on output modules that do not have simultaneous voltage and current measurement capability, select the measurement function as follows.

Front Panel:	SCPI Command:

Not Available	To select the measurement function:[1]
	`SENS:FUNC "VOLT",(@1:4)`
	`SENS:FUNC "CURR",(@1:4)`

If a model has simultaneous voltage and current measurements capability, then BOTH voltage and current are acquired on any triggered measurement, regardless of the setting of the SENSe:FUNCtion command.

Select the Measurement Trigger Source

NOTE An immediate trigger command over the bus will generate an immediate trigger regardless of the trigger source.

Unless you are using a TRIG:ACQ command to trigger the measurement, select a trigger source from the following:

Bus Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).

Pin <number> Selects a pin on the external port connector as the trigger source. You can specify pins 1, 2, or 3. The selected pin must be configured as a Trigger Input in order to be used as a trigger source (see Appendix C)

Transient <channel> Selects the output channel's transient system as the trigger source. <channel> specifies the channel.

When you select a channel, you must also set up that channel's transient system to generate a trigger out signal. Refer to "Generating Trigger Out Signals" and "Program an Arbitrary List" earlier in this chapter.

Use the following commands to select a trigger source:

Front Panel:	SCPI Command:

Not Available	To select Bus triggers for output 1:
	`TRIG:SOUR BUS,(@1)`
	To select Digital pin triggers:
	`TRIG:SOUR PIN<n>,(@1)`
	where n is the pin number.
	To select Transient output triggers:
	`TRIG:SOUR TRAN<n>,(@1)`
	where n is the output channel that will generate the trigger signal.

Initiate the Measurement Trigger System

Next, you must initiate or enable the measurement trigger system.

When the power system is turned on, the trigger system is in the idle state. In this state, the trigger system is disabled, ignoring all triggers. The INITiate commands enable the measurement system to receive triggers. To initiate the measurement trigger system, use:

Front Panel:	SCPI Command:
Not Available	To initiate the measurement trigger system for all four outputs: `INIT:ACQ (@1:4)`

After a trigger is received and the data acquisition completes, the trigger system will return to the idle state. Thus it will be necessary to initiate the measurement system each time a triggered measurement is desired.

Trigger the Measurement

The trigger system is waiting for a trigger signal in the initiated state. You can immediately trigger the measurement as follows:

Front Panel:	SCPI Command:
Not Available	To generate a measurement trigger on output 1: `TRIG:ACQ (@1)` Alternatively, if the trigger source is BUS, you can also program a `*TRG` or an IEEE-488 <get> command.

As previously discussed, a trigger can also be generated by another output channel or an input pin on the digital port connector. If any of these systems are configured as the trigger source, the instrument will wait indefinitely for the trigger signal. If the trigger does not occur, you must manually return the trigger system to the idle state.

The following commands return the trigger system to the idle state:

Front Panel:	SCPI Command:
Select **Measure\Control**. Then select the Abort control.	`ABOR:ACQ (@1)`

5
Introduction to Programming

SCPI Commands 60
SCPI Messages 62
SCPI Conventions and Data Formats 64
SCPI Command Completion 66
Device Clear 66

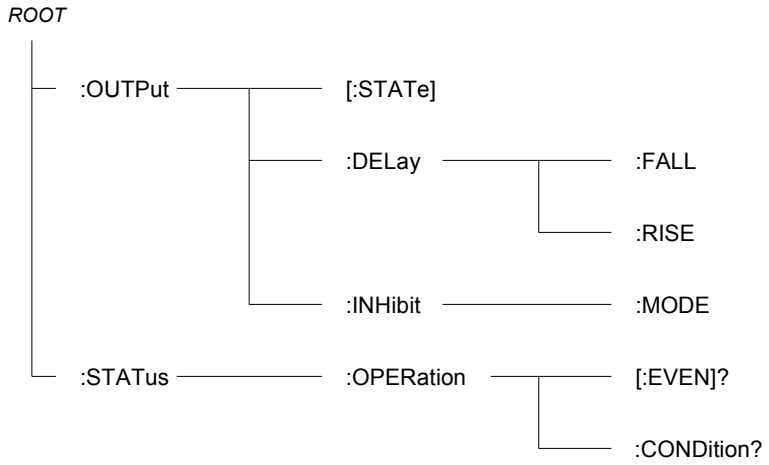
This chapter contains a brief introduction to the SCPI Programming language. SCPI (Standard Commands for Programmable Instruments) is a programming language for controlling instrument functions over the GPIB.

SCPI provides instrument control with a standardized command syntax and style, as well as a standardized data interchange format for various classes of instruments..

SCPI Commands

SCPI has two types of commands, common and subsystem.

- Common commands generally control overall power system functions, such as reset, status, and synchronization. All common commands consist of a three-letter mnemonic preceded by an asterisk: *RST *IDN? *SRE 8
- Subsystem commands perform specific power system functions. They are organized into an inverted tree structure with the "root" at the top. The following figure shows a portion of a subsystem command tree, from which you access the commands located along the various paths.



Multiple Commands in a Message

Multiple SCPI commands can be combined and sent as a single message with one message terminator. There are two important considerations when sending several commands within a single message:

- Use a semicolon to separate commands within a message.
- There is an implied header path that affects how commands are interpreted by the power system.

The header path can be thought of as a string that gets inserted **before** each command within a message. For the first command in a message, the header path is a null string. For each subsequent command the header path is defined as the characters that make up the headers of the previous command in the message up to and including the last colon separator. An example of a message with two commands is:

```
OUTPut:STATe ON,(@1);PROTection:CLEar (@1)
```

which shows the use of the semicolon separating the two commands, and also illustrates the header path concept. Note that with the second command, the leading header "OUTPut" was omitted because after the "OUTPut:STATe ON" command, the header path became

defined as "OUTPut" and thus the instrument interpreted the second command as:

```
OUTPut:PROTection:CLEar (@1)
```

In fact, it would have been syntactically incorrect to include the "OUTP" explicitly in the second command, since the result after combining it with the header path would be:

```
OUTPut:OUTPut:PROTection:CLEar (@1)
```

which is incorrect.

Moving Among Subsystems

In order to combine commands from different subsystems, you need to be able to reset the header path to a null string within a message. You do this by beginning the command with a colon (:), which discards any previous header path. For example, you could clear the output protection and check the status of the Operation Condition register in one message by using a root specifier as follows (the short form is used in the next two examples):

```
OUTP:PROT:CLE(@1);:STAT:OPER:COND?(@1)
```

The following message shows how to combine commands from different subsystems as well as within the same subsystem:

```
VOLT:LEV 7.5,(@1);PROT:STAT ON,(@1);:CURR:LEV 0.25,(@1)
```

Note the use of the optional header LEVel to maintain the correct path within the subsystems, and the use of the root specifier to move between subsystems.

Including Common Commands

You can combine common commands with system commands in the same message. Treat the common command as a message unit by separating it with a semicolon (the message unit separator). Common commands *do not affect the header path*; you may insert them anywhere in the message.

```
OUTPut OFF,(@1);*RCL 1;OUTPut ON,(@1)
```

Using Queries

Observe the following precautions with queries:

- Add a blank space between the query indicator (?) and any subsequent parameter such as a channel list.
- Allocate the proper number of variables for the returned data.
- Read back all the results of a query before sending another command to the power system. Otherwise a *Query Interrupted* error will occur and the unreturned data will be lost.

Coupled Commands

When commands are coupled it means that the value sent by one command is affected by the settings of another command. The following commands are coupled:

- [SOURce:]CURRent and [SOURce:]CURRent:RANGe.
- [SOURce:]VOLTage and [SOURce:]VOLTage:RANGe.

If a range command is sent that places an output on a range with a lower maximum setting than the present level, an error is generated. This also occurs if a level is programmed with a value too large for the present range.

These types of errors can be avoided by sending the both level and range commands as a set, in the same SCPI message. For example,

```
CURRent 10,(@1);CURRent:RANGe 10,(@1)<NL>
```

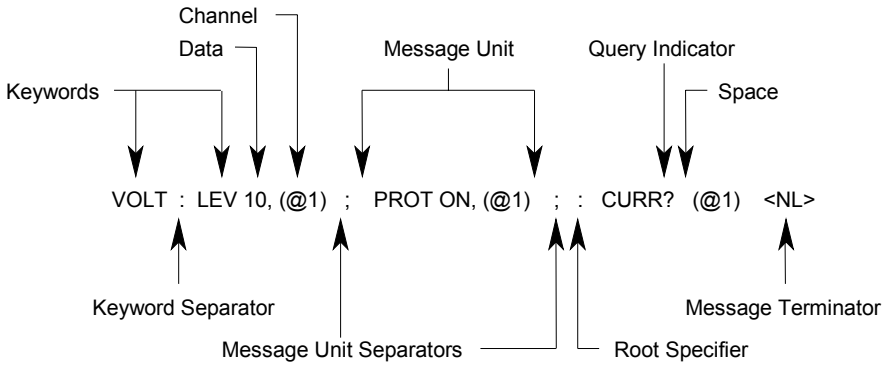
will always be correct because the commands are not executed until the message terminator is received. Because the range and setting information is received as a set, no range/setting conflict occurs.

SCPI Messages

There are two types of SCPI messages, program and response.

- A *program message* consists of one or more properly formatted SCPI commands sent from the controller to the power system. The message, which may be sent at any time, requests the power system to perform some action.
- A *response message* consists of data in a specific SCPI format sent from the power system to the controller. The power system sends the message only when commanded by a program message "query."

The following figure illustrates the SCPI message structure.



The Message Unit

The simplest SCPI command is a single message unit consisting of a command header (or keyword) followed by a message terminator. The message unit may include a parameter after the header. The parameter can be numeric or a string.

```
ABORt<NL>
```

```
VOLTage 20, (@1)
```

Channel List Parameter

The channel parameter is required to address one or more channels. It has the following syntax:

```
(@<channel> [,<channel>][,<channel>][,<channel>])
```

You can also specify a range of sequential channels as follows:

```
<start_channel> : <end_channel>
```

For example, (@2) specifies channel 2 and (@1:3) specifies channels 1 through 3. A maximum of 4 channels may be specified through a combination of single channels and ranges. Query results are channel list order-sensitive. Results are returned in the order they are specified in the list.

NOTE When adding a channel list parameter to a query, you must include a space character between the query indicator (?) and the channel list parameter. Otherwise error –103, Invalid separator will occur.

Headers

Headers, also referred to as keywords, are instructions recognized by the power system. Headers may be in the long form or in the short form. In the long form, the header is completely spelled out, such as VOLTAGE, STATUS, and DELAY. In the short form, the header has only the first three or four letters, such as VOLT, STAT, and DEL.

When the long form notation is used in this document, the capital letters indicate the equivalent short form. For example, MEASure is the long form, and MEAS indicates the short form equivalent.

Query Indicator

Following a header with a question mark turns it into a query (VOLTage?, VOLTage:TRIGgered?). The ? is the query indicator. If a query contains a parameter, place the query indicator at the end of the last header, before the parameter.

```
VOLTage:TRIGgered? MAX,(@1)
```

Message Unit Separator

When two or more message units are combined into a compound message, separate the units with a semicolon.

```
STATus:OPERation?(@1);QUEStionable?(@1)
```

Root Specifier

When it precedes the first header of a message unit, the colon becomes the root specifier. It tells the command parser that this is the root or the top node of the command tree.

Message Terminator

A terminator informs SCPI that it has reached the end of a message. The following messages terminators are permitted:

- newline <NL>, which is ASCII decimal 10 or hex 0A.
- end or identify <END> (EOI with ATN false)
- both of the above <NL><END>
- also <CR><NL>

In the examples of this guide, there is an assumed message terminator at the end of each message.

SCPI Conventions and Data Formats

Conventions

The following SCPI conventions are used throughout this guide.

Angle brackets < >	Items within angle brackets are parameter abbreviations. For example, <NR1> indicates a specific form of numerical data.
Vertical bar |	Vertical bars separate alternative parameters. For example, VOLT | CURR indicates that either "VOLT" or "CURR" can be used as a parameter.
Square Brackets [ ]	Items within square brackets are optional. The representation [SOURce:]VOLTage means that SOURce: may be omitted.
Braces { }	Braces indicate parameters that may be repeated zero or more times. It is used especially for showing arrays. The notation <A>{<,B>} shows that parameter "A" must be entered, while parameter "B" may be omitted or may be entered one or more times.
Parentheses ( )	Items within parentheses are used in place of the usual parameter types to specify a channel list. The notation (@1:3) specifies a channel list that includes channels 1, 2, and 3. The notation (@1,3) specifies a channel list that includes only channels 1 and 3.

Data Formats

Data programmed or queried from the power system is ASCII. The data may be numerical or character string.

Numeric Data Formats

Symbol	Response Formats
<NR1>	Digits with an implied decimal point assumed at the right of the least-significant digit. Examples: 273
<NR2>	Digits with an explicit decimal point. Example: .0273
<NR3>	Digits with an explicit decimal point and an exponent. Example: 2.73E+2
	Parameter Formats
<NRf>	Extended format that includes <NR1>, <NR2> and <NR3>. Examples: 273 273. 2.73E2
<NRf+>	Expanded decimal format that includes <NRf> and MIN MAX. Examples: 273 273. 2.73E2 MAX. MIN and MAX are the minimum and maximum limit values that are implicit in the range specification for the parameter.
<Bool>	Boolean Data. They can be numeric (0, 1), or named (ON, OFF).
<SPD>	String program data. String parameters enclosed in single or double quotes.

Suffixes and Multipliers

Class	Suffix	Unit	Unit with Multiplier
Current	A	ampere	MA (milliampere)
Amplitude	V	volt	MV (millivolt)
Time	S	second	MS (millisecond)
Common Multipliers			
1E3	K	kilo	
1E-3	M	milli	
1E-6	U	micro	

Response Data Types

Symbol	Response Formats
<CRD>	Character Response Data. Permits the return of character strings.
<AARD>	Arbitrary ASCII Response Data. Permits the return of undelimited 7-bit ASCII. This data type has an implied message terminator.
<SRD>	String Response Data. Returns string parameters enclosed in single or double quotes.

SCPI Command Completion

SCPI commands sent to the power system are processed either sequentially or in parallel. Sequential commands finish execution before a subsequent command begins. Parallel commands allow other commands to begin executing while the parallel command is still executing.

The following is a list of parallel commands. You should use some form of command synchronization as discussed in this section before assuming that these commands have completed.

```
OUTPUT:STATE                INITIATE
VOLT                        OUTPUT:PROTECTION:CLEAR
CURR                        FUNC:MODE
```

The *WAI, *OPC, and *OPC? common commands provide different ways of indicating when all transmitted commands, including any parallel ones, have completed their operations. Some practical considerations for using these commands are as follows:

***WAI** This command prevents the power system from processing subsequent commands until all pending operations are completed. For example, the *WAI command can be used to make a current measurement after an output on command has completed:

```
OUTPUT ON,(@1);*WAI;:MEAS:CURR? (@1)
```

***OPC?** This command places a 1 in the Output Queue when all pending operations have completed. Because it requires your program to read the returned value before executing the next program statement, *OPC? can be used to cause the controller to wait for commands to complete before proceeding with its program.

***OPC** This command sets the OPC status bit when all pending operations have completed. Since your program can read this status bit on an interrupt basis, *OPC allows subsequent commands to be executed.

NOTE The trigger subsystem must be in the Idle state for the status OPC bit to be true. As far as triggers are concerned, OPC is false whenever the trigger subsystem is in the Initiated state.

Device Clear

You can send a Device Clear at any time to abort a SCPI command that may be hanging up the GPIB interface. Device Clear clears the input and output buffers of the power system and prepares the power system to accept a new command string. The status registers, error queue, and all configuration states are left unchanged by Device Clear. The following statement shows how to send a device clear over the GPIB interface using *Agilent BASIC:*

```
CLEAR 705        IEEE-488 Device Clear
```

6
Language Dictionary

SCPI Command Summary 68
Calibration Subsystem 72
Measurement Subsystem 74
Output Subsystem 77
Source Subsystem 80
Status Subsystem 87
System Commands 94
Trigger Subsystem 97

This section gives the syntax and parameters for all the IEEE 488.2 SCPI commands and the Common commands used by the power system. It is assumed that you are familiar with the material in chapter 5, which explains the terms, symbols, and syntactical structures used here and gives an introduction to programming. You should also be familiar with chapter 4, in order to understand how the power system functions.

Subsystem commands are specific to instrument functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. The subsystem commands are arranged alphabetically according to the function they perform.

Common commands are defined by the IEEE 488.2 standard to perform common interface functions. They begin with an * and consist of three letters (command) or three letters and a ? (query). Common commands are grouped along with the subsystem commands according to the function they perform.

SCPI Command Summary

Subsystem Commands

NOTE Some [optional] commands have been included for clarity.

SCPI Command	Description
ABORt	
:ACQuire (@chanlist)	Resets the measurement trigger system to the Idle state
:TRANsient (@chanlist)	Resets the transient trigger system to the Idle state
CALibrate	
:CURRent	
[:LEVel] <NRf>, (@channel)	Calibrates the output current programming
:MEASure <NRf>, (@channel)	Calibrates the current measurement
:PEAK (@channel)	Calibrates the peak current limit (Note 1)
:DATA <NRf>	Enters the calibration value
:DATE <SPD>, (@channel)	Sets the calibration date
:DPRog (@channel)	Calibrates the current downprogrammer
:LEVel P1 | P2	Advances to the next calibration step
:PASSword <NRf>	Sets the numeric calibration password
:SAVE	Saves the new cal constants in non-volatile memory
:STATE <Bool> [,<NRf>]	Enables/disables calibration mode
:VOLTage	
[:LEVel] <NRf>, (@channel)	Calibrates the output voltage programming
:CMRR (@channel)	Calibrates the voltage common mode rejection ratio (Note 1)
:MEASure <NRf>, (@channel)	Calibrates the voltage measurement
FETCh (Note 2) | MEASure	
[:SCALar]	
:CURRent [:DC]? (@chanlist)	Returns the average output current
:VOLTage [:DC]? (@chanlist)	Returns the average output voltage
:ARRay	
:CURRent [:DC]? (@chanlist)	Returns the instantaneous output current (Note 2)
:VOLTage [:DC]? (@chanlist)	Returns the instantaneous output voltage (Note 2)
INITiate	
[:IMMediate]	
:ACQuire (@chanlist)	Enables the measurement system to receive triggers (Note 2)
:TRANsient (@chanlist)	Enables the output transient system to receive triggers
:CONTinuous	
:TRANsient <Bool>, (@chanlist)	Enables/disables continuous transient triggers
OUTPut	
[:STATe] <Bool>, [NORelay], (@chanlist)	Enables/disables the specified output channel(s)
:DELay	
:FALL <NRf+>, (@chanlist)	Sets the output turn-off sequence delay
:RISE <NRf+>, (@chanlist)	Sets the output turn-on sequence delay
:INHibit	
:MODE LATChing | LIVE | OFF	Sets the remote inhibit input
:PON	
:STATe RST | RCL0	Programs the Power-On State

SCPI Command	Description
OUTPut (continued)	
:PROTection	
:CLEar (@chanlist)	Resets latched protection
:COUPle <Bool>	Enables/disables channel coupling for protection faults
:DELay <NRf+>, (@chanlist)	Sets over-current protection programming delay
:RELay [:STATe] <Bool>, (@chanlist)	Sets the relay state independently of the output state (Note 3)
SENSe	
:CURRent [:DC]	
:RANGe [:UPPer] <NRf+>, (@chanlist)	Selects the current measurement range (Note 4)
:FUNCtion "VOLTage" | "CURRent", (@chanlist)	Selects the measurement function
:SWEep	
:OFFSet:POINts <NRf+>, (@chanlist)	Defines the trigger offset in the measurement sweep (Note2)
:POINts <NRf+>, (@chanlist)	Defines the number of data points in the measurement (Note 2)
:TINTerval <NRf+>, (@chanlist)	Sets the measurement sample interval (Note 2)
:VOLTage [:DC]	
:RANGe [:UPPer] <NRf+>, (@chanlist)	Selects the voltage measurement range (Note 4)
:WINDow [:TYPE] HANNing | RECTangular, (@chanlist)	Sets measurement window function (Note 2)
[SOURce:]	
CURRent	
[:LEVel]	
[:IMMediate][:AMPLitude] <NRf+>, (@chanlist)	Sets the output current
:TRIGgered [:AMPLitude] <NRf+>, (@chanlist)	Sets the triggered output current
:MODE FIXed | STEP | LIST, (@chanlist)	Sets the current trigger mode
:PROTection	
:STATe <Bool>, (@chanlist)	Enables/disables over-current protection on the selected output
:RANGe <NRf+>, (@chanlist)	Sets the output current range (Note 4)
DIGital	
:INPut:DATA?	Reads the state of the digital port pins
:OUTPut:DATA <NRf>	Sets the digital port
:PIN1 | :PIN2 | :PIN3	
:FUNCtion DIO | DINP | TOUT | TINP | FAUL[1] | INH[2]	Sets the selected pin's function ([1]PIN1 only; [2]PIN3 only)
:POLarity POSitive | NEGative	Sets the selected pin's polarity
LIST	
:COUNt <NRf+> | INFinity, (@chanlist)	Sets the list repeat count (Note 2)
:CURRent [:LEVel] <NRf> {,<NRf>. . .}, (@chanlist)	Sets the current list (Note 2)
:POINts? (@chanlist)	Returns the number of current list points (Note 2)
:DWELl <NRf> {,<NRf>. . .}, (@chanlist)	Sets the list of dwell times (Note 2)
:POINts? (@chanlist)	Returns the number of dwell list points (Note 2)
:STEP ONCE | AUTO, (@chanlist)	Specifies how the list responds to triggers (Note 2)
:TERMinate	
:LAST <Bool>, (@chanlist)	Sets the list termination mode (Note 2)
:TOUTput	
:BOSTep[:DATA] <Bool> {,<Bool>. . .}, (@chanlist)	Sets the steps to generate triggers at the Begin Of Step (Note 2)
:POINts? (@chanlist)	Returns the number of beginning of step list points (Note 2)
:EOSTep[:DATA] <Bool> {,<Bool>. . .}, (@chanlist)	Sets the steps to generate triggers at the End Of Step (Note 2)
:POINts? (@chanlist)	Returns the number of end of step list points (Note 2)
:VOLTage[:LEVel] <NRf> {,<NRf>. . .}, (@chanlist)	Sets the voltage list (Note 2)
:POINts? (@chanlist)	Returns the number of voltage level points (Note 2)
STEP	
:TOUTput <Bool>, (@chanlist)	Generate a trigger output on the voltage or current step transient

SCPI Command	Description
[SOURce:] (continued)	
VOLTage	
[:LEVel]	
[:IMMediate][:AMPLitude] <NRf+>, (@chanlist)	Sets the output voltage
:TRIGgered [:AMPLitude] <NRf+>, (@chanlist)	Sets the triggered output voltage
:MODE FIXed | STEP | LIST, (@chanlist)	Sets the voltage trigger mode
:PROTection	
[:LEVel] <NRf+>, (@chanlist)	Sets the over-voltage protection level
:STATe <Bool>, (@chanlist)	Enables/disables over-voltage protection on the selected output
:RANGe <NRf+>, (@chanlist)	Sets the output voltage range (Note 4)
STATus	
:OPERation	
[:EVENt]? (@chanlist)	Returns the value of the operation event register
:CONDition? (@chanlist)	Returns the value of the operation condition register
:ENABle <NRf>, (@chanlist)	Enables specific bits in the Event register
:NTRansition <NRf>, (@chanlist)	Sets the Negative transition filter
:PTRansition <NRf>, (@chanlist)	Sets the Positive transition filter
:PRESet	Presets all enable and transition registers to power-on
:QUEStionable	
[:EVENt]? (@chanlist)	Returns the value of the questionable event register
:CONDition? (@chanlist)	Returns the value of the questionable condition register
:ENABle <NRf>, (@chanlist)	Enables specific bits in the Event register
:NTRansition <NRf>, (@chanlist)	Sets the Negative transition filter
:PTRansition <NRf>, (@chanlist)	Sets the Positive transition filter
SYSTem	
:CHANnel	
[:COUNt]?	Returns the number of output channels in a mainframe
:MODel? (@chanlist)	Returns the model number of the selected channel
:OPTion? (@chanlist)	Returns the option installed in the selected channel
:SERial? (@chanlist)	Returns the serial number of the selected channel
:COMMunicate	
:RLSTate LOCal | REMote | RWLock	Specifies the Remote/Local state of the instrument
:ERRor?	Returns the error number and error string
:VERSion?	Returns the SCPI version number
TRIGger	
:ACQuire	
[:IMMediate] , (@chanlist)	Triggers the measurement immediately (Note 2)
:SOURce BUS | PIN<pin> | TRAN<chan>, (@chanlist)	Sets the measurement trigger source (Note 2)
:TRANsient	
[:IMMediate] , (@chanlist)	Triggers the output immediately
:SOURce BUS | PIN<pin> | TRAN<chan>, (@chanlist)	Sets the output trigger source

Note 1: Only applies to Models N6751A, N6752A, N6761A, and N6762A.

Note 2: Only applies to Models N6761A, N6762A, and Models N6751A, N6752A. with Test Extensions Option 054.

Note 3: Only applies to Models with Output Relay Option 761.

Note 4: Only applies to Models N6761A and N6762A

Common Commands

Command	Description	Command	Description
*CLS	Clear status	*RDT?	Return output channel descriptions
*ESE <NRf>	Standard event status enable	*RST	Reset
*ESE?	Return standard event status enable	*SAV <NRf>	Saves an instrument state
*ESR?	Return event status register	*SRE <NRf>	Set service request enable register
*IDN?	Return instrument identification	*SRE?	Return service request enable register
*OPC	Enable "operation complete" bit in ESR	*STB?	Return status byte
*OPC?	Return a "1" when operation complete	*TRG	Trigger
*OPT?	Return option number	*TST?	Performs self-test, then returns result
*RCL <NRf>	Recalls a saved instrument state	*WAI	Pauses additional command processing until all device commands are done

*RST Settings

These settings are set by the *RST (Reset) command			
Calibration Function (Note 1)		**Output (continued)**	
CAL:STAT	OFF	OUTP:PROT:DEL	0.02
Current Function		OUTP:REL	OFF
[SOUR:]CURR	MIN	**Measurement Function**	
[SOUR:]CURR:MODE	FIX	SENS:CURR:RANG	MAX
[SOUR:]CURR:PROT:STAT	OFF	SENS:FUNC	“VOLT”
[SOUR:]CURR:RANG	MAX	SENS:SWE:POIN	1024
[SOUR:]CURR:TRIG	MIN	SENS:SWE:OFFS:POIN	0
Digital Function		SENS:SWE:TINT	20.48E–6
[SOUR:]DIG:OUTP:DATA	0	SENS:VOLT:RANG	MAX
List Function (Note 1)		SENS:WIND	RECT
[SOUR:]LIST:COUN	1	**Trigger Function**	
[SOUR:]LIST:CURR	MIN	INIT:CONT:TRAN	OFF
[SOUR:]LIST:DWEL	0.001	TRIG:ACQ:SOUR	BUS
[SOUR:]LIST:STEP	AUTO	TRIG:TRAN:SOUR	BUS
[SOUR:]LIST:TERM:LAST	OFF	**Step Function**	
[SOUR:]LIST:TOUT:BOST	OFF	[SOUR:]STEP:TOUT	FALSE
[SOUR:]LIST:TOUT:EOST	OFF	**Voltage Function**	
[SOUR:]LIST:VOLT	MIN	[SOUR:]VOLT	MIN
Output Function		[SOUR:]VOLT:MODE	FIX
OUTP	OFF	[SOUR:]VOLT:PROT:LEV	MAX
OUTP:DEL:FALL	0	[SOUR:]VOLT:PROT:STAT	ON
OUTP:DEL:RISE	0	[SOUR:]VOLT:RANG	MAX
OUTP:PROT:COUP	OFF	[SOUR:]VOLT:TRIG	MIN

[1] The calibration state and all list settings are not saved by the *SAV command.

Calibration Subsystem

The calibration subsystem lets you calibrate the power system. Refer to Appendix B for details.

NOTE If calibration mode has not been enabled with CALibrate:STATe, the calibration commands will generate an error. Use CALibrate:SAVE to save any changes, otherwise all changes will be lost when you exit calibration mode.

CALibrate:CURRent[:LEVel] <value> (@<channel>)

This command initiates calibration of the output current. The value that you enter selects the range.

CALibrate:CURRent:MEASure <value> (@<channel>)

This command initiates calibration of the current measurement range. The value that you enter selects the range.

CALibrate:CURRent:PEAK (@<channel>)

This command initiates calibration of the peak current limit.

CALibrate:DATA <value>

This command enters a calibration value that you obtain by reading an external meter. You must first select a calibration level (with CALibrate:LEVel) for the value being entered. Data values are expressed in base units - either volts or amperes, depending on which function is being calibrated.

CALibrate:DATE <date> (@<channel>)
CALibrate:DATE?

This command stores the date the module was last calibrated. The calibration date is stored in nonvolatile memory. Enter any ASCII string up to 15 characters. The query returns the date.

NOTE The firmware does not interpret the string format. The information is not used by the firmware. The command is only provided to store the calibration date.

CALibrate:DPRog (@<channel>)

This command initiates calibration of the current downprogrammer.

CALibrate:LEVel {P1|P2}

This command selects the data point in the calibration sequence. **P1** is the first calibration point; **P2** is the second calibration point.

NOTE Some calibration sequences may require some settling time after sending CAL:LEV but before reading the data from the DVM and sending CAL:DATA.

CALibrate:PASSword <password>

This command lets you change the calibration password. A new password is automatically stored in nonvolatile memory and does not have to be stored with CALibrate:SAVE. If the password is set to 0, password protection is removed and the ability to enter calibration mode is unrestricted. The default password is the model number.

CALibrate:SAVE

This command saves calibration constants in non-volatile memory. When exiting calibration mode, the calibration constants in non-volatile memory are restored. If calibration mode is exited without first saving the new constants, the previous constants are restored.

CALibrate:STATe {ON|OFF} [,<password>]
CALibrate:STATe?

This command enables or disables calibration mode. Calibration mode must be enabled for the power system to accept any calibration commands. The first parameter specifies the On (1) or Off (0) state. The second parameter is the password.

A numeric password is required if calibration mode is being enabled and the existing password is not 0. If the password is not entered or is incorrect, an error is generated and the calibration mode remains disabled. The query returns only the state, not the password.

The *RST value = Off.

NOTE When the calibration state is changed from enabled to disabled, new calibration constants are lost unless they have already been stored with CALibrate:SAVE.

CALibrate:VOLTage:CMRR (@<channel>)

This command initiates calibration of the voltage common mode rejection ratio.

CALibrate:VOLTage[:LEVel] <value> (@<channel>)

This command initiates calibration of the output voltage. The value that you enter selects the range. This is because the instrument selects the range with the best resolution for the value entered.

CALibrate:VOLTage:MEASure <value> (@<channel>)

This command initiates calibration of the voltage measurement range. The value that you enter selects the range.

Measurement Subsystem

The measurement subsystem consists of Measure, Fetch, and Sense commands.

Measure commands measure the output voltage or current. They trigger the acquisition of new data before returning the reading. Measurements are performed by digitizing the instantaneous output voltage or current for a specified time interval, storing the results in a buffer, and calculating the average value. Use Measure commands when the measurement does not need to be synchronized with any other event.

Fetch commands return a reading computed from previously acquired data. If you take a voltage measurement, you can fetch only voltage data. If you take a current measurement, you can fetch only current data. Use Fetch commands when it is important that the measurement be synchronized with a triggered event.

Sense commands controls the current measurement range, the bandwidth detector of the power system, and the data acquisition sequence.

NOTE The FETCh:ARRay, MEASure:ARRay, and SENSe commands do not apply to all models. Refer to Chapter 1, "Model Differences" for model-specific information.

```
FETCh:ARRay:CURRent[:DC]? (@<chanlist>)
FETCh:ARRay:VOLTage[:DC]? (@<chanlist>)

MEASure:ARRay:CURRent[:DC]? (@<chanlist>)
MEASure:ARRay:VOLTage[:DC]? (@<chanlist>)
```

These queries return an array containing the digitized output current in amperes or output voltage in volts. The data returned by the FETCh command is the result of the last measurement command or acquisition trigger. The data is valid until the next MEASure or INITiate command occurs.

The output voltage or current is digitized whenever a measurement command is sent or an acquisition trigger occurs. The sampling rate is set by SENSe:SWEep:TINTerval. The position of the trigger relative to the beginning of the data buffer is determined by SENSe:SWEep:OFFSet. The number of points returned is set by SENSe:SWEep:POINts.

FETCh[:SCALar]:CURRent[:DC]? (@<chanlist>)
FETCh[:SCALar]:VOLTage[:DC]? (@<chanlist>)

MEASure[:SCALar]:CURRent[:DC]? (@<chanlist>)
MEASure[:SCALar]:VOLTage[:DC]? (@<chanlist>)

These queries return the DC output current in amperes or output voltage in volts. The data returned by the FETCh command is the result of the last acquisition. The data is valid until the next MEASure or INITiate command occurs.

The output voltage or current is digitized whenever a measurement command is sent or an acquisition trigger occurs. The time interval is set by SENSe:SWEep:TINTerval. The position of the trigger relative to the beginning of the data buffer is determined by SENSe:SWEep:OFFSet. The number of points returned is set by SENSe:SWEep:POINts.

SENSe:CURRent[:DC]:RANGe[:UPPer] {<value>|MIN|MAX}, (@<chanlist>)
SENSe:CURRent[:DC]:RANGe[:UPPer]? (@<chanlist>)

This command selects a DC current measurement range on models that have multiple ranges. The value that you enter must be higher than the maximum current that you expect to measure. Units are in amperes. The instrument selects the range with the best resolution for the value entered. When queried, the returned value is the maximum DC current that can be measured on the range that is presently set.

Refer to Appendix A for the available ranges for each model.

The *RST value = the highest available range.

SENSe:FUNCtion {"VOLTage"|"CURRent"} (@<chanlist>)
SENSe:FUNCtion?

This command selects a measurement function on models that do not have simultaneous voltage and current measurement cabability. This command is required so that the acquisition system knows which measurement function to acquire when a measurement is triggered.

The *RST value = "VOLTage".

SENSe:SWEep:OFFSet:POINts {<points>|MIN|MAX}, (@<chanlist>)
SENSe:SWEep:OFFSet:POINts? (@<chanlist>)

This command defines the offset in a data sweep when an acquire trigger is used on models that have measurement controls. Programmed values can range from -4095 through 2,000,000,000 (2E9). Negative values represent data samples taken prior to the trigger. Positive values represent the delay after the trigger occurs but before the samples are acquired.

The *RST value = 0.

SENSe:SWEep:POINts {<points>|MIN|MAX}, (@<chanlist>)
SENSe:SWEep:POINts? (@<chanlist>)

This command defines the number of points in a measurement on models that have measurement controls. Programmed values can range from 1 to 4096.

The *RST value = 1024.

SENSe:SWEep:TINTerval {<interval>|MIN|MAX}, (@<chanlist>)
SENSe:SWEep:TINTerval? (@<chanlist>)

This command defines the time period between samples in seconds on models that have measurement controls. Programmed values can range from 0.00002048 to 40000 seconds. Values are rounded to the nearest 20.48 microsecond increment.

The*RST value = 20.48 microseconds.

SENSe:VOLTage[:DC]:RANGe[:UPPer] {<value>|MIN|MAX}, (@<chanlist>)
SENSe:VOLTage[:DC]:RANGe[:UPPer]? (@<chanlist>)

This command selects a DC voltage measurement range on models that have multiple ranges. The programmed value must be the maximum voltage that you expect to measure. Units are in volts. The instrument selects the range with the best resolution for the value entered. When queried, the returned value is the maximum DC voltage that can be measured on the range that is presently set.

Refer to Appendix A for the available ranges for each model.

The *RST value = the highest available range.

SENSe:WINDow[:TYPE] {HANNing|RECTangular}, (@<chanlist>)
SENSe:WINDow[:TYPE]? (@<chanlist>)

This command sets the window function used in DC measurement calculations on models that have measurement controls. Select from:

HANNing A signal conditioning window that reduces errors in DC measurement calculations in the presence of periodic signals such as AC line ripple. The Hanning window multiplies each point in the sample by the function cosine^4.

RECTangular A window that returns measurement calculations with no signal conditioning.

Note that neither window function alters the instantaneous voltage or current data returned in the measurement array.

The *RST value = RECTangular.

Output Subsystem

The Output subsystem controls the output, power-on, protection, and relay functions.

```
OUTPut[:STATe] {ON|OFF}, [NORelay],(@<chanlist>)
OUTPut[:STATe]? (@<chanlist>)
```

This command enables or disables the specified output channel(s). The enabled state is ON (1); the disabled state is OFF (0). The state of a disabled output is a condition of zero output voltage and a zero source current. If output and sense relays are installed in the module, they will open when the output is disabled and close when the output is enabled. The query returns 0 if the output is off, and 1 if the output is on.

The NORelay optional parameter lets you turn the output state on or off and leave the state of the relays unchanged. When not specified, the relays open and close as the output is turned off and on.

Separate delays can be programmed for the off-to-on and the on-to-off transition using OUTPut:DELay:RISE and OUTput:DELay:FALL.

The *RST value = OFF.

NOTE Because of internal circuit start-up procedures and any installed relay options, the output on command may take between 35 and 50 milliseconds to complete its function. Conversely, the output off command may take between 20 and 25 milliseconds to complete its function. If you need to mitigate this built-in delay, you can program the output to zero volts rather than using the output on/off command.

```
OUTPut[:STATe]:DELay:FALL {<delay>|MIN|MAX}, (@<chanlist>)
OUTPut[:STATe]:DELay:FALL? (@<chanlist>)
```

This command sets the delay in seconds that the instrument waits before disabling the specified output. It affects on-to-off transitions including changes in the OUTPut:STATe as well as transitions due to changes in the voltage range or current range. It does NOT affect transitions to off caused by protection functions. Delay times can range from 0 to 1.023 seconds in increments of 1 millisecond.

This command allows multiple output channels to turn off in a controlled manner. Each output will not turn off until its delay time has elapsed.

The *RST value = 0.

OUTPut[:STATe]:DELay:RISE {<delay>|MIN|MAX}, (@<chanlist>)
OUTPut[:STATe]:DELay:RISE? (@<chanlist>)

This command sets the delay in seconds that the instrument waits before enabling the specified output. It affects all off-to-on transitions including changes in the OUTPut:STATe as well as transitions due to OUTPut:PROTection:CLEar. Delay times can range from 0 to 1.023 seconds in increments of 1 millisecond.

This command allows multiple output channels to turn on in a controlled manner. Each output will not turn on until its delay time has elapsed.

The *RST value = 0.

OUTPut:INHibit:MODE {LATChing|LIVE|OFF}
OUTPut:INHibit:MODE?

This command selects the mode of operation of the Inhibit input (INH). The inhibit function shuts down ALL output channels in response to an external signal on the Inhibit input. If an output channel has been turned off by OUTPut[:STATe], the inhibit function does not affect the output channel while it is in the OFF state. The Inhibit mode setting is stored in non-volatile memory.

The following modes can be selected:

LATChing Causes a logic-true transition on the Inhibit input to disable all outputs. The outputs remain disabled until the Inhibit input is returned to logic-false and the latched INH status bit is cleared by sending the OUTP:PROT:CLE command or a protection clear command from the front panel.

LIVE Allows the enabled outputs to follow the state of the Inhibit input. When the Inhibit input is true, the outputs are disabled. When the Inhibit input is false, the outputs are re-enabled.

OFF The Inhibit input is ignored.

OUTPut:PON:STATe {RST|RCL0}
OUTPut:PON:STATe?

This command determines if the power-on state is set to the *RST (RST) state or the instrument state stored in memory location 0 (RCL0). The parameter is saved in non-volatile memory. Instrument states can be stored using the *SAV command.

Refer to *RST and *RCL under “System Commands” for more information.

OUTPut:PROTection:CLEar (@<chanlist>)

This command clears the latched protection status that disables the output when an over-voltage, over-temperature, over-current, power-fail, or Inhibit status condition is detected. All conditions that generate the fault must be removed before the latched status can be cleared. The output is restored to the state it was in before the fault condition occurred.

NOTE If a protection shutdown occurs during an output list, the list continues running even though the output is disabled. When the protection status is cleared and the output becomes enabled again, the output will be set to the values of the step that the list is presently at.

OUTPut:PROTection:COUPle {ON|OFF}
OUTPut:PROTection:COUPle?

This command enables/disables output coupling for protection faults. When enabled, ALL output channels are disabled when a protection fault occurs on any output channel. The enabled state is On (1); the disabled state is Off (0). When disabled, only the affected output channel is disabled when a protection fault is triggered.

The *RST value = OFF.

OUTPut:PROTection:DELay {<delay>|MIN|MAX}, (@<chanlist>)
OUTPut:PROTection:DELay? (@<chanlist>)

This command sets the over-current protection programming delay. This prevents momentary changes in status that can occur during reprogramming from triggering the over-current protection function. Programmed values can range from 0 to 255 milliseconds.

The *RST value = 20 ms.

OUTPut:RELay[:STATe] {ON|OFF},(@<chanlist>)
OUTPut:RELay[:STATe]? (@<chanlist>)

This command allows the relay state to be programmed independently of the output state. When the relay state is On (1), the relays contacts close. When the relay state is Off (0), the relay contacts open.

Do not use the relays as the means of connecting/disconnecting the output while it is active. Use this command if you want to turn the output off while having the relays remain closed, or turn the output on while having the relays remain open.

In most applications, the output relays should be controlled in coordination with the output state. This functionality is provided by OUTPut[:STATe].

The *RST value = OFF.

Source Subsystem

The Source subsystem programs the current, digital, list, step, and voltage functions.

NOTE The SOURce:CURRent:RANge, SOURce:VOLTage:RANge, and SOURce:LIST commands do not apply to all models. Refer to Chapter 1, "Model Differences" for model-specific information.

```
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]
{<value>|MIN|MAX}, (@<chanlist>)
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]? (@<chanlist>)
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]
{<value>|MIN|MAX}, (@<chanlist>)
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]? (@<chanlist>)
```

These commands set the immediate and the triggered current level of the output channel. The values are programmed in amperes. The immediate level is the output current setting. The triggered level is a stored value that is transferred to the output when a Step transient is triggered. Note that the [SOURce:]CURRent command is coupled with [SOURce:]CURRent:RANGe.

The *RST value = MIN.

```
[SOURce:]CURRent:MODE {FIXed|STEP|LIST}, (@<chanlist>)
[SOURce:]CURRent:MODE? (@<chanlist>)
```

These commands determine what happens to the output current when the transient system is initiated and triggered.

FIXed The output voltage remains at the immediate value.

STEP The output goes to the triggered level when a trigger occurs.

LIST The output follows the programmed step value when a trigger occurs. This function does not apply to all models (see Chapter 1, "Model Differences").

The *RST value = FIXed.

```
[SOURce:]CURRent:PROTection:STATe {ON|OFF}, (@<chanlist>)
[SOURce:]CURRent:PROTection:STATe? (@<chanlist>)
```

This command enables or disables the over-current protection (OCP) function. The enabled state is On (1); the disabled state is Off (0). If the over-current protection function is enabled and the output goes into constant current operation, the output is disabled and the Questionable Condition status register OCP bit is set.

The current limit setting determines when the output channel goes into constant current operation. An over-current condition can be cleared with OUTPut:PROTection:CLEar after the cause of the condition is removed.

The *RST value = OFF.

[SOURce:]CURRent:RANGe {<value>|MIN|MAX}, (@<chanlist>)
[SOURce:]CURRent:RANGe? (@<chanlist>)

This command only applies to models that have programmable ranges. Refer to Appendix A for the available ranges for each model.

This command sets the output current range. Units are in amperes. The instrument selects the range with the best resolution for the value entered. When queried, the returned value is the maximum DC current that can be output on the range that is presently set.

This command is coupled with the [SOURce:]CURRent command. This means that if a range command is sent that places an output on a range with a lower maximum current than the present current level, an error is generated. This also occurs if a current level is programmed with a value too large for the present range.

These types of errors can be avoided by sending the both level and range commands in the same SCPI message. When the range and setting information is received as a set, no range/setting conflict occurs.

The *RST value = the highest available range.

NOTE If programming a range value causes a range change to occur while the output is enabled, the output will be temporarily disabled while the range switch occurs. The transition from on-to-off and then from off-to-on will also be delayed by the settings of OUTPut:DELay:FALL and OUTPut:DELay:RISE.

[SOURce:]DIGital:INPut:DATA?

This query reads the state of the digital control port. The query returns the state of pins 1, 2, and 3 in bits 0, 1, and 2 respectively.

[SOURce:]DIGital:OUTPut:DATA <value>
[SOURce:]DIGital:OUTPut:DATA?

This command sets the output data on the digital control port when that port is configured for Digital I/O operation. The port has three signal pins and a digital ground pin. In the binary-weighted value that is written to the port, pin 1 is controlled by bit 0, pin 2 is controlled by bit 1, and Pin 3 is controlled by bit 2.

The query returns the last programmed value of bits 0, 1, and 2. To read the actual state of the pin, use [SOURce:]DIGital:INPut:DATA?

```
[SOURce:]DIGital:PIN1:FUNCtion {DIO|DINPut|TOUTput|TINPut|FAULt}
[SOURce:]DIGital:PIN1:FUNCtion?
[SOURce:]DIGital:PIN2:FUNCtion {DIO|DINPut|TOUTput|TINPut}
[SOURce:]DIGital:PIN2:FUNCtion?
[SOURce:]DIGital:PIN3:FUNCtion {DIO|DINPut|TOUTput|TINPut|INHibit}
[SOURce:]DIGital:PIN3:FUNCtion?
```

These commands set the functions of the three digital port pins. The pin functions are saved in non-volatile memory.

DIO The pin is a general-purpose ground-referenced digital input/output. The output can be set with [SOURce:]DIGital:OUTPut:DATA <value>.

DINPut The pin is in digital input-only mode. The digital output data of the corresponding pin is ignored.

TOUTput The pin is configured as a trigger output. When configured as a trigger output, the pin will only generate output triggers if the Step or List transient system has been configured to generated trigger signals.

TINPut The pin is configured as a trigger input. When configured as a trigger input, the pin can be selected as a source of measurement and transient trigger signals.

FAULt Applies only to pin 1. Setting FAULt means that pin 1 functions as an isolated fault output. The fault signal is true when any output is in a protected state (from OCP, OVP, OT, PF, or INH). Note also that Pin 2 serves as the isolated common for pin 1. When pin 1 is set to the FAULt function, the instrument ignores any commands to program pin 2. Queries of pin 2 will return FAULt. If pin 1 is changed from FAULt to another function, pin 2 is set to DINPut.

INHibit Applies only to pin 3. When pin 3 is configured as an inhibit input, a true signal at the pin will disable all output channels.

```
[SOURce:]DIGital:PIN1:POLarity {POSitive|NEGative}
[SOURce:]DIGital:PIN1:POLarity?
[SOURce:]DIGital:PIN2:POLarity {POSitive|NEGative}
[SOURce:]DIGital:PIN2:POLarity?
[SOURce:]DIGital:PIN3:POLarity {POSitive|NEGative}
[SOURce:]DIGital:PIN3:POLarity
```

These commands set the polarity of the three digital port pins. The pin polarities are saved in non-volatile memory.

Setting a polarity to POSitive means that a logical true signal is a voltage high at the pin. Setting the polarity NEGative means that a logical true signal is a voltage low at the pin. For trigger inputs and outputs, POSitive means a rising edge; NEGative means a falling edge.

[SOURce:]LIST:COUNt {<count>|MIN|MAX|INFinity}, (@<chanlist>)
[SOURce:]LIST:COUNt? (@<chanlist>)

This command sets the number of times that the list is executed before it is completed. Applies only to models with list capability. The range is 1 through 256. Use INFinity to execute a list indefinitely. In this case, use ABORt:TRANsient to stop the list.

The *RST value = 1.

[SOURce:]LIST:CURRent[:LEVel] <curr> {,<curr>}, (@<chanlist>)
[SOURce:]LIST:CURRent[:LEVel]? (@<chanlist>)

This command specifies the current setting for each list step in amperes. Applies only to models with list capability. A comma-delimited list of up to 512 steps may be programmed. The order in which the values are entered determines the sequence when the list executes.

The *RST value = 1 step with a value of MIN.

[SOURce:]LIST:CURRent:POINts? (@<chanlist>)

This query returns the number of points (steps) programmed in the current list. Applies only to models with list capability.

[SOURce:]LIST:DWELl <time> {,<time>}, (@<chanlist>)
[SOURce:]LIST:DWELl? (@<chanlist>)

This command specifies the dwell time for each list step. Applies only to models with list capability. A comma-delimited list of up to 512 steps may be programmed. Dwell time is the time that the output will remain at a specific step. Dwell times can be programmed from 0 to 262.143 seconds with the following resolution:

Range in seconds	Resolution
0 to 0.262143	1 microsecond
0 to 2.62143	10 microseconds
0 to 26.2143	100 microseconds
0 to 262.143	1 millisecond

At the end of the dwell time, the output state of the unit depends upon the LIST:STEP program settings. See LIST:STEP

The order in which the values are entered determines the sequence when the list executes.

The *RST value = 1 step with a value of 0.001.

[SOURce:]LIST:DWELl:POINts? (@<chanlist>)

This query returns the number of points (steps) in the dwell list. Applies only to models with list capability.

[SOURce:]LIST:STEP {ONCE|AUTO}, (@<chanlist>)
[SOURce:]LIST:STEP? (@<chanlist>)

This command specifies how the list responds to triggers. Applies only to models with list capability.

ONCE Causes the output to remain at the present step until a trigger advances it to the next step. Triggers that arrive during the dwell time are ignored.

AUTO Causes the output to automatically advance to each step, after the receipt of an initial starting trigger. The steps are paced by the dwell list. As each dwell time elapses, the next step is immediately output.

The *RST value = AUTO.

[SOURce:]LIST:TERMinate:LAST {ON|OFF}, (@<chanlist>)
[SOURce:]LIST:TERMinate:LAST? (@<chanlist>)

This command determines the output value when the list terminates. Applies only to models with list capability. The state is either ON (1) or OFF (0). When ON, the output voltage or current remains at the value of the last list step. The value of the last voltage or current list step becomes the IMMediate value when the list completes. When OFF, and also when the list is aborted, the output returns to the settings it was at before the list started.

The *RST value = OFF.

[SOURce:]LIST:TOUTput:BOSTep[:DATA] {ON|OFF}{,{ON|OFF}}, (@<chanlist>)
[SOURce:]LIST:TOUTput:BOSTep[:DATA]? (@<chanlist>)

This command specifies which list steps generate a trigger out signal at the beginning of the list step. Applies only to models with list capability. A comma-delimited list of up to 512 steps may be programmed. The state is either ON (1) or OFF (0). A trigger is only generated when the state is set to ON. BOSTep is an abbreviation for “beginning of step”.

The *RST value = 1 step with a value of OFF.

[SOURce:]LIST:TOUTput:EOSTep[:DATA] {ON|OFF}{,{ON|OFF}}, (@<chanlist>)
[SOURce:]LIST:TOUTput:EOSTep[:DATA]? (@<chanlist>)

This command specifies which list steps generate a trigger out signal at the end of the list step’s dwell time. Applies only to models with list capability. A comma-delimited list of up to 512 steps may be programmed. The state is either ON (1) or OFF (0). A trigger is only generated when the state is set to ON. EOSTep is an abbreviation for “end of step”.

The *RST value = 1 step with a value of OFF.

```
[SOURce:]LIST:VOLTage[:LEVel] <volt> {,<volt>}, (@<list>)
[SOURce:]LIST:VOLTage[:LEVel]? (@<chanlist>)
```

This command specifies the voltage setting for each list step in volts. Applies only to models with list capability. Up to 512 steps may be programmed. The values are separated by commas. The order in which the values are entered determines the sequence when the list executes.

The *RST value = 1 step with a value of MIN.

```
[SOURce:]LIST:VOLTage:POINts? (@<chanlist>)
```

This query returns the number of points (steps) in the voltage list, not the point values. Applies only to models with list capability.

```
[SOURce:]STEP:TOUTput {ON|OFF}, (@<chanlist>)
[SOURce:]STEP:TOUTput? (@<chanlist>)
```

This command specifies whether an output trigger signal is generated when a transient voltage or current step occurs. The state is either ON (1) or OFF (0). A trigger is generated when the state is True.

The *RST value = OFF.

```
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]
{<value>|MIN|MAX}, (@<list>)
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]? (@<chanlist>)
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]
{<value>|MIN|MAX}, (@<list>)
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]? (@<chanlist>)
```

These commands set the immediate and the triggered voltage level of the output channel. The values are programmed in volts. The immediate level is the output voltage setting. The triggered level is a stored value that is transferred to the output when a Step transient is triggered. Note that the [SOURce:]VOLTage command is coupled with [SOURce:]VOLTage:RANGe..

The *RST value = MIN.

```
[SOURce:]VOLTage:MODE {FIXed|STEP|LIST}, (@<chanlist>)
[SOURce:]VOLTage:MODE? (@<chanlist>)
```

These commands determine what happens to the output voltage when the transient system is initiated and triggered.

FIXed The output voltage remains at the immediate value.

STEP The output goes to the triggered level when a trigger occurs.

LIST The output follows the programmed list step value when a trigger occurs. This function does not apply to all models (see Chapter 1, "Model Differences").

The *RST value = FIXed.

[SOURce:]VOLTage:PROTection:LEVel {<value>|MIN|MAX}, (@<chanlist>)
[SOURce:]VOLTage:PROTection:LEVel? (@<chanlist>)

This command sets the overvoltage protection (OVP) level of the output channel. The values are programmed in volts. If the output voltage exceeds the OVP level, the output is disabled and the Questionable Condition status register OV bit is set. An overvoltage condition can be cleared with the Output Protection Clear command after the condition that caused the OVP trip is removed. The OVP function can be disabled using VOLTage:PROTection:STATe.

The *RST value = MAX.

[SOURce:]VOLTage:PROTection:STATe {ON|OFF}, (@<chanlist>)
[SOURce:]VOLTage:PROTection:STATe? (@<chanlist>)

This command enables or disables the overvoltage protection (OVP) function. The enabled state is ON (1); the disabled state is OFF (0). When the overvoltage protection circuit trips, the output of the channel shuts down.

If output disconnect relays are installed, they will open.

The *RST value = ON.

[SOURce:]VOLTage:RANGe {<value>|MIN|MAX}, (@<chanlist>)
[SOURce:]VOLTage:RANGe? (@<chanlist>)

This command only applies to models that have programmable ranges. Refer to Appendix A for the available ranges for each model.

This command sets the output voltage range. Units are in volts. The instrument selects the range with the best resolution for the value that is entered. When queried, the returned value is the maximum voltage that can be output on the range that is presently set.

This command is coupled with the [SOURce:]VOLTage command. This means that if a range command is sent that places an output on range with a lower maximum voltage than the present voltage level, an error is generated. This also occurs if a voltage level is programmed with a value too large for the present range.

These types of errors can be avoided by sending the both level and range commands in the same SCPI message. When the range and setting information is received as a set, no range/setting conflict occurs.

The *RST value = the highest available range.

NOTE If programming a range value causes a range change to occur while the output is enabled, the output will be temporarily disabled while the range switch occurs. The transition from on-to-off and then from off-to-on will also be delayed by the settings of OUTPut:DELay:FALL and OUTPut:DELay:RISE.

Status Subsystem

Status register programming lets you determine the operating condition of the power system at any time. The power system has three groups of status registers; Operation, Questionable, and Standard Event. The Operation and Questionable status groups each consist of the Condition, Enable, and Event registers as well as NTR and PTR filters.

The Standard Event status group is also programmed using Common commands. Common commands control additional status functions such as the Service Request Enable and the Status Byte registers.

Operation Status Group

The Operation Status registers record signals that occur during normal operation. As shown below, the group consists of a Condition, PTR/NTR, Event, and Enable register. The outputs of the Operation Status register group are logically-ORed into the OPERation summary bit (7) of the Status Byte register.

Questionable Status Group

The Questionable Status registers record signals that indicate abnormal operation. As shown below, the group consists of the same register types as the Status Operation group. The outputs of the Questionable Status group are logically-ORed into the QUEStionable summary bit (3) of the Status Byte register.

Standard Event Status Group

The Standard Event registers are programmed by Common commands. The Standard Event event register latches events relating to communication status. It is a read-only register that is cleared when read. The Standard Event enable register functions similarly to the enable registers of the Operation and Questionable status groups.

Status Byte Register

This register summarizes the information from all other status groups as defined in the *IEEE 488.2 Standard Digital Interface for Programmable Instrumentation*.

MSS and RQS Bits

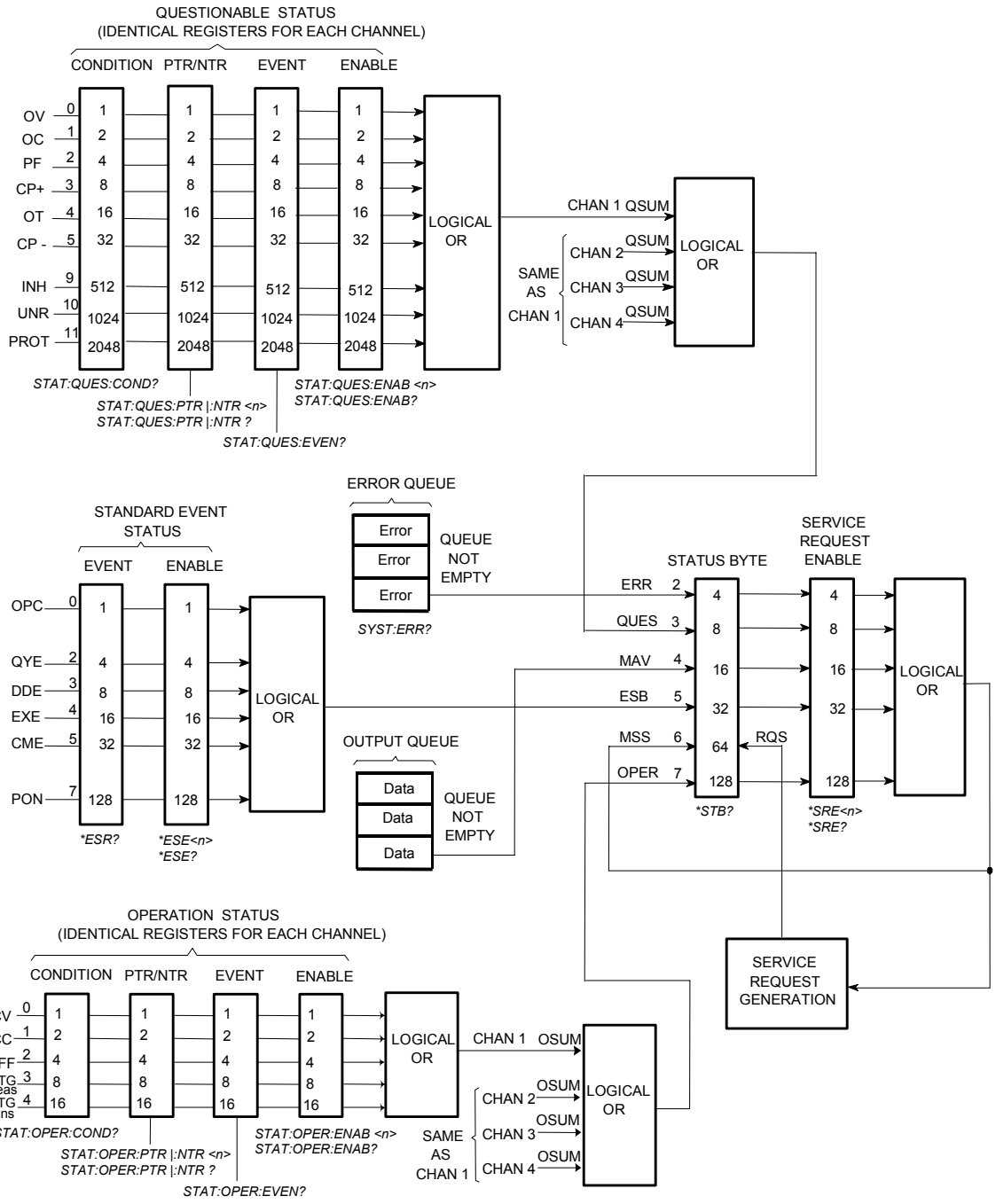
MSS is a real-time (unlatched) summary of all Status Byte register bits that are enabled by the Service Request Enable register. MSS is set whenever the power system has one or more reasons for requesting service. *STB? reads the MSS in bit position 6 of the response but does not clear any of the bits in the Status Byte register.

The RQS bit is a latched version of the MSS bit. Whenever the power system requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller

does a serial poll, RQS is cleared inside the register and returned in bit position 6 of the response. The remaining bits of the Status Byte register are not disturbed.

MAV Bit and Output Queue

The Output Queue is a first-in, first-out (FIFO) data register that stores power system-to-controller messages until the controller reads them. Whenever the queue holds one or more bytes, it sets the MAV bit (4) of the Status Byte register.



STATus:PRESet

This command sets all defined bits in the Status system's PTR registers and clears all bits in the NTR and Enable registers.

Operation Register	Questionable Register	Preset Settings
STAT:OPER:ENAB	STAT:QUES:ENAB	0 all bits disabled
STAT:OPER:NTR	STAT:QUES:NTR	0 all bits disabled
STAT:OPER:PTR		31 all defined bits enabled
	STAT:QUES:PTR	3647 all defined bits enabled

STATus:OPERtion[:EVENt]? (@<chanlist>)

This query returns the value of the Operation Event register. The Event register is a read-only register, which stores (latches) all events that are passed by the Operation NTR and/or PTR filter. Reading the Operation Event register clears it. The bit configuration of the Operation status registers is as follows:

Bit Position	15-5	4	3	2	1	0
Bit Value	–	16	8	4	2	1
Bit Name	–	WTG-tran	WTG-meas	OFF	CC	CV

WTG-tran = The transient system is waiting for a trigger.
WTG-meas = The measurement system is waiting for a trigger
OFF = The output is programmed off
CC = The output is in constant current
CV = The output is in constant voltage

STATus:OPERtion:CONDition? (@<chanlist>)

This query returns the value of the Operation Condition register. That is a read-only register, which holds the live (unlatched) operational status of the power system.

STATus:OPERation:ENABle <value>, (@<chanlist>)
STATus:OPERation:ENABle? (@<chanlist>)

This command and its query set and read the value of the Operational Enable register. This register is a mask for enabling specific bits from the Operation Event register to set the operation summary bit (OPER) of the Status Byte register. This bit (bit 7) is the logical OR of all the Operatonal Event register bits that are enabled by the Status Operation Enable register.

```
STATus:OPERation:NTRansition <value>, (@<chanlist>)
STATus:OPERation:PTRansition <value>, (@<chanlist>)
STATus:OPERation:NTRansition? (@<chanlist>)
STATus:OPERation:PTRansition? (@<chanlist>)
```

These commands set and read the value of the Operation NTR (Negative-Transition) and PTR (Positive-Transition) registers. These registers serve as polarity filters between the Operation Condition and Operation Event registers to cause the following actions:

- When a bit in the Operation NTR register is set to 1, then a 1-to-0 transition of the corresponding bit in the Operation Condition register causes that bit in the Operation Event register to be set.
- When a bit of the Operation PTR register is set to 1, then a 0-to-1 transition of the corresponding bit in the Operation Condition register causes that bit in the Operation Event register to be set.
- If the same bits in both NTR and PTR registers are set to 1, then any transition of that bit at the Operation Condition register sets the corresponding bit in the Operation Event register.
- If the same bits in both NTR and PTR registers are set to 0, then no transition of that bit at the Operation Condition register can set the corresponding bit in the Operation Event register.

```
STATus:QUEStionable[:EVENt]? (@<chanlist>)
```

This query returns the value of the Questionable Event register. The Event register is a read-only register, which stores (latches) all events that are passed by the Questionable NTR and/or PTR filter. Reading the Questionable Event register clears it. The bit configuration of the Questionable status registers is as follows:

Bit Position	15-12	11	10	9	8-6	5	4	3	2	1	0
Bit Value	–	2048	1024	512	–	32	16	8	4	2	1
Bit Name	–	PROT	UNR	INH	–	CP –	OT	CP+	PF	OC	OV

PROT = The output has been disabled because it is coupled to a protection condition that occurred on another channel.
UNR = The output is unregulated
INH = The output is inhibited by an external signal
CP– = The output is limited by the negative power limit
OT = The over-temperature protection has tripped
CP+ = The output is limited by the positive power limit
PF = The output is disabled by the power-fail - which may be caused by a low-line or bownout condition on the AC line
OC = The output is disabled by the over-current protection
OV = The output is disabled by the over-voltage protection

```
STATus:QUEStionable:CONDition? (@<chanlist>)
```

This query returns the value of the Questionable Condition register. That is a read-only register, which holds the real-time (unlatched) questionable status of the power system.

STATus:QUEStionable:ENABle <value>, (@<chanlist>)
STATus:QUEStionable:ENABle? (@<chanlist>)

This command and its query set and read the value of the Questionable Enable register. This register is a mask for enabling specific bits from the Questionable Event register to set the questionable summary bit (QUES) of the Status Byte register. This bit (bit 3) is the logical OR of all the Questionable Event register bits that are enabled by the Questionable Status Enable register.

STATus:QUEStionable:NTRansiton <value>, (@<chanlist>)
STATus:QUEStionable:PTRansiton <value>, (@<chanlist>)
STATus:QUEStionable:NTRansition? (@<chanlist>)
STATus:QUEStionable:PTRansition? (@<chanlist>)

These commands set or read the value of the Questionable NTR (Negative-Transition) and PTR (Positive-Transition) registers. These registers serve as polarity filters between the Questionable Condition and Questionable Event registers to cause the following actions:

- When a bit of the Questionable NTR register is set to 1, then a 1-to-0 transition of the corresponding bit of the Questionable Condition register causes that bit in the Questionable Event register to be set.
- When a bit of the Questionable PTR register is set to 1, then a 0-to-1 transition of the corresponding bit in the Questionable Condition register causes that bit in the Questionable Event register to be set.
- If the same bits in both NTR and PTR registers are set to 1, then any transition of that bit at the Questionable Condition register sets the corresponding bit in the Questionable Event register.
- If the same bits in both NTR and PTR registers are set to 0, then no transition of that bit at the Questionable Condition register can set the corresponding bit in the Questionable Event register.

***CLS**

This command causes the following actions on the status system:

- Clears the Standard Event Status, Operation Status Event, and Questionable Status Event registers
- Clears the Status Byte and the Error Queue
- If *CLS immediately follows a program message terminator (<NL>), then the output queue and the MAV bit are also cleared.

***ESE**
***ESE?**

This command programs the Standard Event Status Enable register bits. The programming determines which events of the Standard Event Status Event register (see *ESR?) are allowed to set the ESB (Event Summary Bit) of the Status Byte register. A "1" in the bit position enables the corresponding event.

All of the enabled events of the Standard Event Status Event Register are logically ORed to cause the Event Summary Bit (ESB) of the Status Byte Register to be set. The query reads the Standard Event Status Enable register. The bit configuration of the Standard Event register is as follows:

Bit Position	7	6	5	4	3	2	1	0
Bit Value	128	–	32	16	8	4	–	1
Bit Name	PON	–	CME	EXE	DDE	QUE	–	OPC

PON = Power-on has occurred
CME = Command error
EXE = Execution error
DDE = Device-dependent error
QUE = Query error
OPC = Operation complete

***ESR?**

This query reads the Standard Event Status Event register. Reading the register clears it. The bit configuration is the same as the Standard Event Status Enable register (see *ESE).

***OPC**
***OPC?**

The command is mainly used for program synchronization. It causes the instrument to set the OPC bit (bit 0) of the Standard Event Status register when the instrument has completed all pending operations sent before the *OPC command. *Pending operations* are complete when:

- All commands sent before *OPC, including paralleled commands, have been completed. Most commands are sequential and are completed before the next command is executed. Commands that affect output voltage, current, or state, relays, and trigger actions are executed in parallel with subsequent commands. *OPC provides notification that all parallel commands have completed.
- All triggered actions are completed

*OPC does not prevent processing of subsequent commands, but the OPC bit will not be set until all pending operations are completed.

*OPC? causes the instrument to place an ASCII "1" in the Output Queue when all pending operations are completed. *OPC? does not suspend processing of commands.

***SRE**
***SRE?**

This command sets the value of the Service Request Enable Register. This register determines which bits from the Status Byte Register are summed to set the Master Status Summary (MSS) bit and the Request for Service (RQS) summary bit. A 1 in any Service Request Enable Register bit position enables the corresponding Status Byte Register bit. All such enabled bits are then logically ORed to cause the MSS bit (bit 6) of the Status Byte Register to be set.

When the controller conducts a serial poll in response to SRQ, the RQS bit is cleared, but the MSS bit is not. When *SRE is cleared (by programming it with 0), the power system cannot generate an SRQ to the controller. The query returns the current state of *SRE.

***STB?**

This query reads the Status Byte register, which contains the status summary bits and the Output Queue MAV bit. Reading the Status Byte register does not clear it. The input summary bits are cleared when the appropriate event registers are read. The MAV bit is cleared at power-on, by *CLS, or when there is no more response data available.

A serial poll also returns the value of the Status Byte register, except that bit 6 returns Request for Service (RQS) instead of Master Status Summary (MSS). A serial poll clears RQS, but not MSS. When MSS is set, it indicates that the power system has one or more reasons for requesting service.

Bit Position	7	6	5	4	3	2	1 – 0
Bit Value	128	64	32	16	8	4	–
Bit Name	OPER	MSS (RQS)	ESB	MAV	QUES	ERR	–

OPER = Operation status summary
MSS = Master status summary
(RQS) = Request for service
ESB = Event status byte summary
MAV = Message available
QUES = Questionable status summary
ERR = Error queue not empty

***WAI**

This command instructs the power system not to process any further commands until all pending operations are completed. Pending operations are as defined under the *OPC command. *WAI can be aborted only by sending the power system a Device Clear command.

System Commands

System commands control system functions that are not directly related to output control, measurement, or status functions. Common commands are also used to control system functions.

SYSTem:CHANnel[:COUNt]?

This query returns the number of output channels installed in a mainframe.

SYSTem:CHANnel:MODel? (@<chanlist>)

This query returns the model numbers of the selected output channels. Model numbers are comma-delimited.

SYSTem:CHANnel:OPTion? (@<chanlist>)

This query returns a list of options installed in each channel given in the channel list. The list of options for each channel is surrounded by double quotes. If there are no options installed in a channel, an empty pair of double quotes is returned.

SYSTem:CHANnel:SERial? (@<chanlist>)

This query returns the serial numbers of the selected output channels. Serial numbers are comma-delimited.

SYSTem:COMMunicate:RLSTate {LOCal|REMote|RWLock} (@<chanlist>)
SYSTem:COMMunicate:RLSTate? (@<chanlist>)

This command configures the remote/local state of the instrument according to the following settings.

LOCal The instrument is set to front panel and remote interface control.

REMote The instrument is set to front panel and remote interface control.

RWLock The front panel keys are disabled. The instrument can only be controlled via the remote interface.

The remote/local state can also be set by interface commands over the GPIB and some other IO interfaces. When multiple remote programming interfaces are active, the interface with the most recently changed remote/local state determines the instrument's remote/local state.

The remote/local state is unaffected by *RST or any SCPI commands other than SYSTem:COMMunicate:RLState. At power-on, the state is LOCal.

SYSTem:ERRor?

This query returns the next error number and its corresponding message string from the error queue. The queue is a FIFO (first-in, first-out) buffer that stores errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns 0, “No error”. If more errors are accumulated than the queue can hold, the last error in the queue will be -350, “Too many errors” (see Appendix D for error codes).

SYSTem:VERSion?

This query returns the SCPI version number to which the instrument complies. The returned value is of the form YYYY.V, where YYYY represents the year and V is the revision number for that year.

*IDN?

This query requests the power system to identify itself. It returns a string of four fields separated by commas.

Field	Information
Agilent Technologies	Manufacturer
N67xxA	Mainframe model number followed by a letter suffix
0	Zero or Mainframe serial number if available
<A>.xx.xx	Revision levels of firmware

*OPT?

This query requests the mainframe to identify any installed options. A *0* indicates no options are installed.

*RCL <state>

This command restores the power system to a state that was previously stored in memory locations 0 through 1 with the *SAV command. All instrument states are recalled with the following exceptions:

- The trigger system is set to the Idle state by an implied ABORt command (this cancels any uncompleted trigger actions).
- Calibration is disabled by setting CALibration:STATe to OFF.
- All list settings are set to their *RST values.
- All status registers are set to their PRESet values.

NOTE The device state stored in location 0 is automatically recalled at power turn-on when the Output Power-On state is set to RCL 0.

*RDT?

This query returns a description of the output channels installed in a mainframe. Semicolons separate multiple channel descriptions.

Field	Information
CHAN <c>	Channel number
description	Description of the output channel

*RST

This command resets the volatile memory of the power system to a factory-defined state (see "*RST Settings" at the beginning of this chapter).

*RST also forces the ABORt:ACQuire and ABORt:TRANsient commands. This cancels any measurement or output trigger actions presently in process, and resets the two WTG bits in the Status Operation Condition register.

*SAV <state>

CAUTION This command causes a write cycle to nonvolatile memory. Nonvolatile memory has a finite maximum number of write cycles. Programs that repeatedly cause write cycles to nonvolatile memory can eventually exceed the maximum number of write cycles and cause the memory to fail.

This command stores the present state of the power system to the specified location in non-volatile memory. Up to 2 states can be stored - in locations 0 and 1. Any state previously stored in the same location will be overwritten. Use the *RCL command to retrieve instrument states. Refer to *RST Settings" at the beginning of this chapter for a list of instrument settings that can be saved.

If a particular state is desired at power-on, it should be stored in location 0. It will then be automatically recalled at power turn-on if the Output Power-On state is set to RCL0.

Note that list data (and the calibration state) is not saved as part of the *SAV operation. This means that all list data that is sent to the instument will be lost when the power system is turned off.

Also, data saved in non-volatile memory, described in the Non-volatile Factory Settings table at the end of chapter 3, is not affected by the *SAV command.

*TST?

This query causes the power system to do a self-test and report any errors. A 0 indicates the power system passed self-test. A 1 indicates one or more tests failed. Selftest errors are written to the error queue (see Appendix D). Note that *TST? also forces an *RST command.

Trigger Subsystem

The Trigger subsystem consists of the Abort, Initiate, and Trigger commands.

Abort commands cancel any triggerd actions.

Initiate commands initialize the trigger system. This enables the trigger system to receive triggers.

Trigger commands control the remote triggering of the power system. They specify the trigger source for the transient and the measurement system and also generate software triggers.

```
ABORt:ACQuire (@<chanlist>)
ABORt:TRANsient (@<chanlist>)
```

These commands cancel any measurement or transient trigger actions presently in process. The two WTG bits in the Status Operation Condition register are also reset. These commands are executed at power-on and upon execution of *RST.

```
INITiate[:IMMediate]:ACQuire (@<chanlist>)
INITiate[:IMMediate]:TRANsient (@<chanlist>)
```

These commands control the enabling of both measurement and transient triggers. When a trigger is initiated, an event on a selected trigger source causes the specified triggering action to occur. If the trigger system is not initiated, all triggers are ignored.

```
INITiate:CONTinuous:TRANsient {ON|OFF},(@<chanlist>)
INITiate:CONTinuous:TRANsient? @<chanlist>)
```

This command continuously initiates the output trigger system. The enabled state is ON (1); the disabled state is OFF (0). With continuous triggering disabled, the output trigger system must be initiated for each trigger using the INITiate:TRANsient command.

The *RST value = OFF.

```
TRIGger:ACQuire[:IMMediate] (@<chanlist>)
```

This command sends an immediate trigger to the measurement system. When the trigger system is initiated, a measurement trigger causes the power system to measure the output voltage or current and store the results in a buffer. The measured quantity, voltage or current is specified by the SENSe:FUNCtion command.

```
TRIGger:ACQuire:SOURce {BUS|PIN<pin>|TRANsient<chan>}, (@<chanlist>)
TRIGger:ACQuire:SOURce? (@<chanlist>)
```

This command selects the trigger source for the measurement trigger system. The following trigger sources can be selected:

BUS GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).

PIN<pin> Selects an output port connector pin. Pins 1 – 3 can be configured as external trigger sources. The [SOURce:]DIGital:PIN<n>:FUNCtion command programs the function of each pin. The [SOURce:]DIGital:PIN<n>:POLarity command programs the polarity of each pin.

TRANsient<chan> Selects the transient system of one of the output channels as the external trigger source. The following commands are used to generate triggers from the transient system: [SOURce:]STEP:TOUTput, [SOURce:]LIST:TOUTput:BOSTep, and [SOURce:]LIST:TOUTput:EOSTep.

The *RST value = BUS.

TRIGger:TRANsient[:IMMediate], (@<chanlist>)

This command generates an immediate transient trigger regardless of the selected trigger source. Output triggers affect the following functions: voltage, current, and current limit. You must initiate the output trigger system before you can send any triggers.

When sent, the output trigger will:

- Initiate an output change as specified by the Current Triggered or Voltage Triggered commands.
- Clears the WTG-tran bit in the Status Operation Condition register after the transient trigger sequence has completed.

TRIGger:TRANsient:SOURce {BUS|PIN<pin>|TRANsient<chan>}, (@<chanlist>)
TRIGger:TRANsient:SOURce?

This command selects the trigger source for the output trigger system. The following trigger sources can be selected:

BUS GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).

PIN<pin> Selects an output port connector pin. Pins 1 – 3 can be configured as external trigger sources. The [SOURce:]DIGital:PIN<n>:FUNCtion command programs the function of each pin. The [SOURce:]DIGital:PIN<n>:POLarity command programs the polarity of each pin.

TRANsient<chan> Selects the transient system of one of the output channels as the trigger source. The following commands are used to generate triggers from the transient system: [SOURce:]STEP:TOUTput, [SOURce:]LIST:TOUTput:BOSTep, and [SOURce:]LIST:TOUTput:EOSTep.

The *RST value = BUS.

*TRG

This command generates a trigger when the trigger subsystem has BUS selected as its source. The command has the same affect as the Group Execute Trigger (<GET>) command.

7
Programming Examples

Output Programming Example 100
List Programming Example 102
Digitizer Programming Example 104

This chapter contains several example programs to help you develop programs for your own application. The example programs are for illustration only, and are provided with the assumption that you are familiar with the programming language being demonstrated and the tools used to create and debug procedures. See Chapter 6, “Language Dictionary” for the SCPI comand syntax.

You have a royalty-free right to use, modify, reproduce and distribute the example programs (and/or any modified version) in any way you find useful, provided that you agree that Agilent Technologies has no warranty, obligations, or liability for any example programs.

The example programs are in Microsoft Visual BASIC 6.0 using the VISA COM IO library. You must first load the VISA COM library to use these examples. The VISA COM IO library is available with version M or later of the Agilent IO libraries for Windows.

NOTE

Before using the example code in Visual BASIC, you must reference two VISA COM objects. In Visual BASIC, go to **Projects>References** and select **Agilent VISA COM Resource Manager 1.0** (filename= AgtRM.dll) and **VISA COM 1.0 Type Library** (filename = VisaCom.tlb). To use this sample code in Visual Basic .NET, see the VISA COM documentation to reference VISA COM in a Visual BASIC project. Copy the code provided in this chapter and call the subroutine for each example.

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Output Programming Example

This is a simple program that sets a voltage, current, overvoltage, and the status of over current protection. When done, the program checks for instrument error and gives a message if there is an error.

```
Sub main_List()
    Dim IDN As String
    Dim GPIBaddress As String
    Dim ErrString As String

    ' This variable controls the channel number to be programmed
    Dim channel As String

    ' This variable controls the voltage
    Dim VoltSetting As Double

    ' This variable measures the voltage
    Dim MeasureVoltSetting As Double

    ' This variable controls the current
    Dim CurrSetting As Double

    ' These variables control the over voltage protection settings
    Dim overVoltOn As Long
    Dim overVoltSetting As Double

    ' These variables control the over current protection
    Dim overCurrentOn As Long
    Dim ocercurrentSetting As Double

    'These variable are neccessary to initialize the VISA COM.
    Dim ioMgr As AgilentRMLib.SRMCls
    Dim Instrument As VisaComLib.FormattedIO488
    Dim ioAddress As String

    ' The following command line provides the program with the VISA name of the
    ' interface that it will be communication with.
    ' It is currently set to use GPIB to communicate
    GPIBaddress = "GPIB0::5::INSTR"

    ' Use the following line for LAN communication
    ' TCPIPaddress="TCPIP0::141.25.36.214"

    ' use the following line instead for USB communication
    ' USBaddress = "USB0::2391::1799::US00000002"

    ' Initialize the VISA COM communication
    Set ioMgr = New AgilentRMLib.SRMCls
    Set Instrument = New VisaComLib.FormattedIO488
    Set Instrument.IO = ioMgr.Open(GPIBaddress)

    ' This variable can be changed to program any channel in the mainframe
    channel = "(@1)"                                    ' channel 1

    VoltSetting = 3
    CurrSetting = 1.5                                   ' amps
    overVoltSetting = 10

    With Instrument
```

```
        ' Send a power reset to the instrument
        .WriteString "*RST"

        ' Query the instrument for the IDN string
        .WriteString "*IDN?"
        IDN = .ReadString


        ' Set voltage
        .WriteString "VOLT" & Str$(VoltSetting) & "," & channel

        ' Ensure that over voltage protection on
        .WriteString "VOLT:PROT:STAT ON," & channel

        ' Set the over voltage level
        .WriteString "VOLT:PROT:LEV " & Str$(overVoltSetting) & "," & channel

        ' Turn on over current protection
        .WriteString "CURR:PROT:STAT ON," & channel

        ' Set current level
        .WriteString "CURR " & Str$(CurrSetting) & "," & channel

        ' Turn the output on
        .WriteString "OUTP ON," & channel

        ' Measure the voltage
        .WriteString "MEAS:VOLT? " & channel
        MeasureVoltString = .ReadString
        MsgBox "Measured Voltage is " & MeasureVoltString & "At channel" & channel

        ' Check instrument for any errors
        .WriteString "Syst:err?"
        ErrString = .ReadString

        ' give message if there is an error
        If Val(ErrString) Then
            MsgBox "Error in instrument!" & vbCrLf & ErrString
        End If
    End With

End Sub
```

List Programming Example

This program executes a 10 point current and voltage list. It also specifies 10 different dwell times. When done the program checks for instrument error and gives a message if there is an error. For ease in reading, error checking is not included.

```
Sub main_List()
    Dim IDN As String
    Dim GPIBaddress As String
    Dim ErrString As String
    Dim channel As String

    ' These next three strings are the points in the list.
    ' All three strings are the same length.
    ' The first one controls voltage, the second current, and the third dwell time
    Const voltPoints = "1,2,3,4,5,6,7,8,9,10"
    Const currPoints = "0.5,1,1.5,2,2.5,3,3.5,4,4.5,5"
    Const dwellPoints = "1,2,0.5,1,0.25,1.5,0.1,1,0.75,1.2"

    'These variable are neccessary to initialize the VISA COM.
    Dim ioMgr As AgilentRMLib.SRMCls
    Dim Instrument As VisaComLib.FormattedIO488
    Dim ioAddress As String

    ' The following command line provides the program with the VISA name of the
    ' interface that it will be communication with.
    ' It is currently set to use GPIB to communicate
    GPIBaddress = "GPIB1::5::INSTR"

    ' Use the following line for LAN communication
    ' TCPIPaddress="TCPIP0::141.25.36.214"

    ' use the following line instead for USB communication
    ' USBaddress = "USB0::2391::1799::US00000002"

    ' Initialize the VISA COM communication
    Set ioMgr = New AgilentRMLib.SRMCls
    Set Instrument = New VisaComLib.FormattedIO488
    Set Instrument.IO = ioMgr.Open(GPIBaddress)


    ' This variable can be changed to program any channel in the mainframe
    channel = "(@1)"                                        ' channel 1


    With Instrument
        ' Send a power reset to the instrument
        .WriteString "*RST"

        ' Query the instrument for the IDN string
        .WriteString "*IDN?"
        IDN = .ReadString

        ' Set the voltage mode to list
        .WriteString "VOLT:MODE LIST," & channel

        ' Set the current mode to list
        .WriteString "CURR:MODE LIST," & channel
```

```
        ' Send the voltage list points
        .WriteString "LIST:VOLT " & voltPoints & "," & channel

        ' Send the Current list points
        .WriteString "LIST:CURR " & currPoints & "," & channel

        ' Send the dwell points
        .WriteString "LIST:DWEL " & dwellPoints & "," & channel

        ' Turn the output on
        .WriteString "OUTP ON," & channel

        ' Set the trigger source to bus
        .WriteString "TRIG:TRAN:SOUR BUS," & channel

        ' Initiate the transient system
        .WriteString "INIT:TRAN " & channel

        ' Trigger the unit
        .WriteString "*TRG"

        ' Check instrument for any errors
        .WriteString "Syst:err?"
        ErrString = .ReadString

        ' give message if there is an error
        If Val(ErrString) Then
            MsgBox "Error in instrument!" & vbCrLf & ErrString
        End If
    End With

End Sub
```

Digitizer Programming Example

This program uses the voltage in step mode and also demonstrates how to set up and use the digitizer.

```
Sub main_List()
    Dim IDN As String
    Dim GPIBaddress As String
    Dim ErrString As String
    Dim channel As String
    Dim measPoints As Long
    Dim measOffset As Long
    Dim Voltage As Double
    Dim finalVoltage As Double
    Dim timeInterval As Double
    Dim VoltPoints() As Variant
    Dim i As Long

    'These variable are neccessary to initialize the VISA COM.
    Dim ioMgr As AgilentRMLib.SRMCls
    Dim Instrument As VisaComLib.FormattedIO488

    ' disable button
    Command1.Enabled = False

    ' The following command line provides the program with the VISA name of the
    ' interface that it will be communication with.
    ' It is currently set to use GPIB to communicate
    GPIBaddress = "GPIB0::5::INSTR"

    ' This controls the number of points the measurement system measures
    measPoints = 100

    ' This controls the number of points to offset the measurement (positive for
    ' forward, negative for reverse)
    measOffset = 0

    ' this sets the time between points
    timeInterval = 0.0025

    ' this variable controls the voltage
    ' it can be hard coded into the viPrintf command as well
    Voltage = 5

    ' This is the final voltage that will be triggered
    finalVoltage = 10

    ' This variable can be changed to program any channel in the mainframe
    channel = "(@1)"                          ' channel 1

    ' Initialize the VISA COM communication
    Set ioMgr = New AgilentRMLib.SRMCls
    Set Instrument = New VisaComLib.FormattedIO488
    Set Instrument.IO = ioMgr.Open(GPIBaddress)

    With Instrument
        ' Send a power reset to the instrument
        .WriteString "*RST"

        ' Query the instrument for the IDN string
        .WriteString "*IDN?"
```

```
        IDN = .ReadString

        ' Put the Voltage into step mode which causes it to transition from one
        ' voltage to another upon receiving a trigger
        .WriteString "VOLT:MODE STEP," & channel

        ' program to voltage setting
        .WriteString "VOLT" & Str$(Voltage) & "," & channel

        ' Go to final value
        .WriteString "VOLT:TRIG" & Str$(finalVoltage) & "," & channel

        ' Turn the output on
        .WriteString "OUTP ON," & channel

        ' Set the bus as the transient trigger source
        .WriteString "TRIG:TRAN:SOUR BUS," & channel

        ' Set the number of points for the measurement system to use as an offset
        .WriteString "SENS:SWE:OFFS:POIN" & Str$(measOffset) & "," & channel

        ' Set the number of points that the measurement system uses
        .WriteString "SENS:SWE:POIN" & Str$(measPoints) & "," & channel

        ' Set the time interval between points
        .WriteString "SENS:SWE:TINT" & Str$(timeInterval) & "," & channel

        ' Set the measurement trigger source
        .WriteString "TRIG:ACQ:SOUR BUS," & channel

        ' Initiate the measurement trigger system
        .WriteString "INIT:ACQ " & channel

        ' Initiate the transient trigger system
        .WriteString "INIT:TRAN " & channel

        ' Trigger the unit
        .WriteString "*TRG"

        ' Read back the voltage points
        .WriteString "FETC:ARR:VOLT? " & channel
        VoltPoints = .ReadList

        ' Print the first 10 voltage points
        For i = 0 To 9
            Debug.Print i, VoltPoints(i)
        Next i

        ' Check instrument for any errors
        .WriteString "Syst:err?"
        ErrString = .ReadString

        ' give message if there is an error
        If Val(ErrString) Then
            MsgBox "Error in instrument!" & vbCrLf & ErrString
        End If
    End With

    Command1.Enabled = True

End Sub
```

A
Specifications

Performance Specifications 108
Supplemental Characteristics 110
Auto-Ranging Characteristic 115
Outline Diagram 115

This chapter lists the specifications and supplemental characteristics of the Agilent N6700 Modular Power System. A dimensional line drawing of the mainframe is included at the end of the chapter.

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 55°C, and derated above 40°C. Sensing is at the output terminals of the power system after a 30-minute warm-up period. Sense terminals must be externally jumpered to their respective output terminals.

Supplemental characteristics are not warranted but are descriptions of performance determined either by design or type testing. All supplemental characteristics are typical unless otherwise noted.

Performance Specifications

Agilent Models N6751A/N6752A and N6761A/N6762A

	N6751A / N6752A	N6761A / N6762A
DC Output Ratings:		
Voltage	50 V	50 V
Current	5 A / 10A	1.5 A / 3 A
Power	50 W / 100 W	50 W / 100 W
Output Ripple and Noise (PARD): (from 20 Hz – 20 MHz)		
CV peak-to-peak NOTE 1	6 mV	6 mV
CV rms	1 mV	1 mV
Load Effect (Regulation): NOTE 2		
Voltage	2 mV	0.5 mV
Current	2 mA	30 µA
Source Effect (Regulation):		
Voltage	1 mV	0.5 mV
Current	1 mA	30 µA
Programming Accuracy: NOTE 3 (at 23 °C ±5 °C after a 30 minute warm-up)		
Voltage high range	0.06% + 19 mV	0.016% + 6 mV
Voltage low range (≤ 5.5 V)	N/A	0.016% + 1.5 mV
Current high range	0.1% + 20 mA	0.04% + 200 µA
Current low range (≤ 100 mA)	N/A	0.04% + 15 µA
Measurement Accuracy: (at 23 °C ±5 °C)		
Voltage high range	0.05% + 20 mV	0.016% + 6 mV
Voltage low range (≤ 5.5 V)	N/A	0.016% + 1.5 mV
Current high range	0.1% + 4 mA	0.03% + 200 µA
Current low range (≤ 100 mA)	N/A	0.03% + 15 µA
Load Transient Recovery Time: (time to recover to within the settling band following a load change - from 60% to 100% and from 100% to 60% of full load for models N6751A & N6761A - from 50% to 100% and from 100% to 50% of full load for models N6752A &N6762A.)		
Voltage settling band	± 75 mV	± 75 mV
Time	< 100 µs	< 150 µs

[1] For typical values, see Supplemental Characteristics.

[2] With an output change from no load to full load, up to a maximum load-lead drop of 1 V per lead.

[3] Applies from minimum to maximum programming range. (see Supplemental Characteristics)

Agilent Models N6731A - N6735A and N6742A - N6745A

	N6731A	N6732A/N6742A	N6733A/N6743A	N6734A/N6744A	N6735A/N6745A
DC Output Ratings:					
Voltage	5 V	8 V	20 V	35 V	50 V
Current	10 A	6.25 A / 10 A	2.5 A / 5 A	1.5 A / 3 A	0.8 A / 1.6 A
Power	50 W	50 W / 80 W	50 W / 100 W	52.5 W / 105 W	40 W / 80 W
Output Ripple and Noise (PARD): (from 20 Hz – 20 MHz)					
CV peak-to- peak	10 mV	12 mV	14 mV	15 mV	20 mV
CV rms	2 mV	2 mV	3 mV	5 mV	9 mV
Load Effect (Regulation): NOTE 1					
Voltage	2 mV	2 mV	2 mV	4 mV	6 mV
Current	2 mA	2 mA	2 mA	2 mA	2 mA
Source Effect (Regulation):					
Voltage	1 mV	2 mV	2 mV	4 mV	6 mV
Current	1 mA	1 mA	1 mA	1 mA	1 mA
Programming Accuracy: NOTE 2 (at 23 °C ± 5 °C after a 30 minute warm-up)					
Voltage	0.1% + 19 mV	0.1% + 19 mV	0.1% + 20 mV	0.1% + 35 mV	0.1% + 60 mV
Current	0.15% + 20 mA	0.15% + 20 mA	0.15% + 20 mA	0.15% + 20 mA	0.15% + 20 mA
Measurement Accuracy: (at 23 °C ±5 °C)					
Voltage	0.1% + 20 mV	0.1% + 20 mV	0.1% + 20 mV	0.1% + 35 mV	0.1% + 60 mV
Current	0.15% + 20 mA	0.15% + 10 mA	0.15% + 5 mA	0.15% + 4 mA	0.15% + 4 mA
Load Transient Recovery Time: (time to recover to within the settling band following a load change from 50% to 100% and from 100% to 50% of full load.)					
Voltage settling band	± 80mV	± 80mV	± 200mV	± 200mV	± 200mV
Time	< 200 µs	< 200 µs	< 200 µs	< 200 µs	< 200 µs

[1] With an output change from no load to full load, up to a maximum load-lead drop of 1 V per lead.

[2] Applies from minimum to maximum programming range. (see Supplemental Characteristics)

Supplemental Characteristics

Agilent Models N6751A/N6752A and N6761A/N6762A

	N6751A / N6752A	N6761A / N6762A
Programming Ranges:		
Voltage high range	20 mV – 51 V	15 mV – 51 V
Voltage low range (≤ 5.5 V)	N/A	12 mV – 5.5 V
Current high range	10 mA - 5.1A/10 mA- 10.2A	1 mA - 1.53 A/1 mA - 3.06 A
Current low range (≤ 0.1 A)	N/A	0.1 mA – 0.1 A [NOTE 1]
Programming Resolution:		
Voltage high range	3.5 mV	880 µV
Voltage low range (≤ 5.5 V)	N/A	90 µV
Current high range	3.25 mA	60 µA
Current low range (≤ 0.1 A)	N/A	2 µA
Measurement Resolution:		
Voltage high range	1.8 mV	440 µV
Voltage low range (≤ 5.5 V)	N/A	44 µV
Current high range	410 µA	30 µA
Current low range (≤ 0.1 A)	N/A	1 µA
Programming Temperature Coefficient per °C:		
Voltage high range	18 ppm + 160 µV	18 ppm + 140 µV
Voltage low range (≤ 5.5 V)	N/A	40 ppm + 70 µV
Current high range	100 ppm + 45 µA	33 ppm + 10 µA
Current low range (≤ 0.1 A)	N/A	60 ppm + 1.5 µA
Measurement Temperature Coefficient per °C:		
Voltage high range	25 ppm + 35 µV	23 ppm + 40 µV
Voltage low range (≤ 5.5 V)	N/A	30 ppm + 40 µV
Current high range	60 ppm + 3 µA	40 ppm + 0.3 µA
Current low range (≤ 0.1 A)	N/A	50 ppm + 0.3 µA
Output Ripple and Noise (PARD):		
CV peak-to-peak (typical)	4 mV	4 mV
CC rms:	2 mA	2 mA
Common Mode Noise: (from 20 Hz – 20 MHz; from either output to chassis)		
rms	500 µA	500 µA
peak-to-peak	< 2 mA	< 2 mA
Over-voltage Protection:		
Accuracy	0.25% + 250 mV	0.25% + 250 mV
Response time	50 µs from occurrence of over-voltage condition to start of output shutdown	

[1] If you are operating the unit below 255 µA in constant current mode, the output may become unregulated with the following load conditions: The load resistance is <175 mΩ **and** the load inductance is >20 µH. If this occurs, an UNRegulated flag will be generated and the output current may rise above the programmed value but will remain less than 255 µA.

Agilent Models N6751A/N6752A and N6761A/N6762A (continued)

	N6751A / N6752A	N6761A / N6762A
Maximum Up-programming Time with full resistive load: (time from 10% to 90% of total voltage excursion)		
Voltage setting from 0 V to 10 V	0.2 ms	0.6 ms
Voltage setting from 0 V to 50 V	1.5 ms	2.2 ms
Maximum Up-programming Settling Time with full resistive load: (time from start of voltage change to within 50mV of final value)		
Voltage setting from 0 V to 10 V	0.5 ms	0.9 ms
Voltage setting from 0 V to 50 V	4.0 ms	4.0 ms
Maximum Down-programming Time with no load: (time from start of voltage change to output voltage < 0.5 V)		
Voltage setting from 10 V to 0 V	0.3 ms	0.3 ms
Voltage setting from 50 V to 0 V	1.3 ms	1.3 ms
Maximum Down-programming Settling Time with no load: (time from start of voltage change to output voltage within 50mV of final value)		
Voltage setting from 10 V to 0 V	0.45 ms	0.45 ms
Voltage setting from 50 V to 0 V	1.4 ms	1.4 ms
Down-programming Time with 1000 µF load: NOTE 2 (time from start of voltage change to output voltage < 0.5 V)		
Voltage setting from 10 V to 0 V	2.1 ms	4.5 ms
Voltage setting from 50 V to 0 V	11 ms	23 ms
Down-programming Capability:		
Continuous power	7 W	7 W
Peak current	7 A	3.8 A
Remote Sense Capability:	Outputs can maintain specifications with up to a 1-volt drop per load lead.	
Series and Parallel Operation:	Similarly rated outputs can be operated directly in parallel or can be connected for straight series operation. Auto-series and auto-parallel operation is not available.	
Load Cross Regulation:		
Voltage, from no load to full load	1 mV	0.5 mV
Current, from no load to full load	1 mA	5 µA

[2] Modules can discharge a 1000µF capacitor from 50V to 0V at a rate of 4 times/second.

Agilent Models N6731A - N6735A and N6742A - N6745A

	N6731A	N6732A/N6742A	N6733A/N6743A	N6734A/N6744A	N6735A/N6745A
Programming Ranges:					
Voltage	20 mV – 5.1 V	20 mV – 8 .16 V	20 mV – 20.4 V	20 mV – 35.7 V	20 mV – 51 V
Current	10 mA – 10.2 A	10 mA – 6.375 A/ 10 mA – 10.2 A	10 mA – 2.55 A/ 10 mA – 5.1 A	10 mA – 1.53 A/ 10 mA – 3.06 A	10 mA – 0.816 A/ 10 mA – 1.63 A
Programming Resolution:					
Voltage	3.5 mV	4 mV	5 mV	9 mV	13 mV
Current	5 mA	3.25 mA	3.25 mA	3.25 mA	3.25 mA
Measurement Resolution:					
Voltage	3 mV	4 mV	10 mV	18 mV	30 mV
Current	10 mA	7 mA	3 mA	2 mA	1 mA
Output Ripple and Noise (PARD):					
CC rms	8 mA	4 mA	2 mA	2 mA	2 mA
Common Mode Noise:					
(from 20 Hz – 20 MHz; from either output to chassis)					
Rms	1 mA	1 mA	1 mA	1 mA	1 mA
peak-to-peak	< 10 mA	< 10 mA	< 10 mA	< 10 mA	< 10 mA
Over-voltage Protection:					
Accuracy	0.25% + 250 mV	0.25% + 250 mV	0.25% + 250 mV	0.25% + 250 mV	0.25% + 300 mV
Response time	50 µs from occurrence of over-voltage condition to start of output shutdown				
Maximum Up-programming and Down-programming Time with full resistive load:					
(time from 10% to 90% of total voltage excursion)					
Voltage setting from 0 V to full scale and full scale to 0V	10 ms	10 ms	10 ms	10 ms	10 ms
Maximum Up-programming and Down-programming Settling Time with full resistive load:					
(time from start of voltage change until voltage settles within 0.1% of the full-scale voltage of its final value)					
Voltage setting from 0 V to full scale and full scale to 0V	100 ms	100 ms	100 ms	100 ms	100 ms
Remote Sense Capability:					
	Outputs can maintain specifications with up to a 1-volt drop per load lead.				
Series and Parallel Operation:					
	Similarly rated outputs can be operated directly in parallel or can be connected for straight series operation. Auto-series and auto-parallel operation is not available.				

Agilent N6700A MPS Mainframe

	N6700A
Command Processing Time:	
From receipt of command to start of the output change	≤ 1 ms
Protection Response Characteristics:	
INH input	5 µs from receipt of inhibit to start of shutdown
Fault on coupled outputs	< 10 µs from receipt of fault to start of shutdown
Digital Control Characteristics:	
Maximum voltage ratings	+16.5 VDC/– 5 VDC between pins (pin 4 is internally connected to chassis ground).
Pins 1 and 2 as FLT output	Maximum low-level output voltage = 0.5 V @ 4 mA Maximum low-level sink current = 4 mA Typical high-level leakage current = 0.14 mA @ 16.5 VDC
Pins 1, 2, 3 as digital/trigger outputs (pin 4 = common)	Maximum low-level output voltage = 0.5 V @ 4 mA; 1 V @ 50 mA; 1.75 V @ 100 mA Maximum low-level sink current = 100 mA Typical high-level leakage current = 0.12 mA @ 16.5 VDC
Pins 1, 2, 3 as digital/trigger inputs and pin 3 as INH input (pin 4 = common)	Maximum low-level input voltage = 0.8 V Minimum high-level input voltage = 2 V Typical low-level current = 2 mA @ 0 V (internal 2.2k pull-up) Typical high-level leakage current = 0.12 mA @ 16.5 VDC
Interface Capabilities:	
GPIB:	SCPI - 1993, IEEE 488.2 compliant interface
USB 2.0:	Requires Agilent I/O Library version M.01.01.04
10/100 LAN:	Requires Agilent I/O library version L.01.01
Built-in Web server	Requires Internet Explorer 5+ or Netscape 6.2+
Environmental Conditions	
Operating environment	Indoor use, installation category II (for AC input), pollution degree 2
Temperature range	0°C to 55°C (output derated above 40°C)
Relative humidity	Up to 95%
Altitude	Up to 2000 meters
Storage temperature	-30°C to 70°C

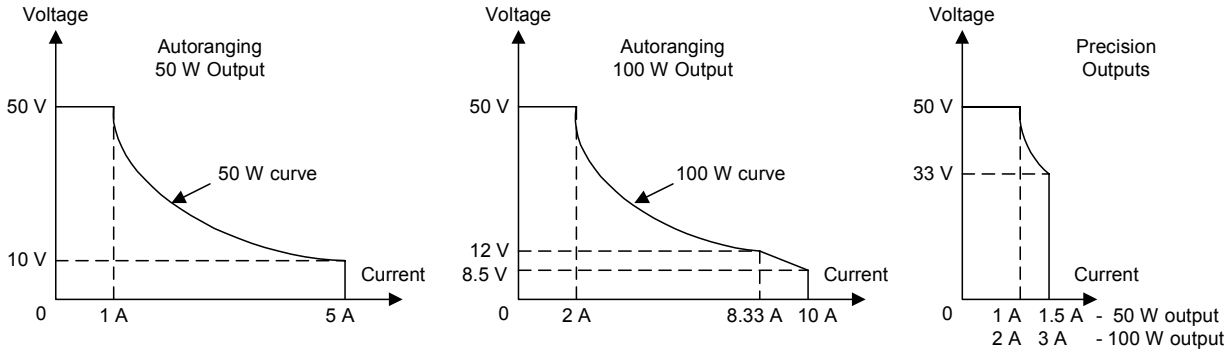
Agilent N6700A MPS Mainframe

	N6700A
Regulatory Compliance:	
EMC	Complies with the European EMC directive 89/336/EEC for Class A test and measurement products. Complies with the Australian standard and carries the C-Tick mark. This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada. **Electrostatic discharges greater than 1 kV near the I/O connectors may cause the unit to reset and require operator intervention.**
Safety	Complies with the European Low Voltage Directive 73/23/EEC and carries the CE-marking. This product also complies with the US and Canadian safety standards for test and measurement products.
Acoustic Noise Declaration:	
This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.	Sound Pressure Lp <70 dB(A), * At Operator Position, * Normal Operation, * According to EN 27779 (Type Test). Schalldruckpegel Lp <70 dB(A) * Am Arbeitsplatz, * Normaler Betrieb, * Nach EN 27779 (Typprüfung).
Output Terminal Isolation:	
Maximum rating	No output terminal may be more than 240 VDC from any other terminal or chassis ground.
AC Input:	
Nominal Input Ratings	100 VAC – 240 VAC; 50/60Hz
Input Range	86 VAC – 264 VAC
Power Consumption	1000 VA typical (1100 VA maximum with power factor correction)
Fuse	Internal fuse (not customer accessible)
Dimensions:	
Height	44.45 mm / 1.75 in.
Width	432.5 mm / 17.03 in.
Depth	596.9 mm / 23.5 in.
Weight:	
With 4 installed modules	Net: 12.78 kg; 28 lbs.

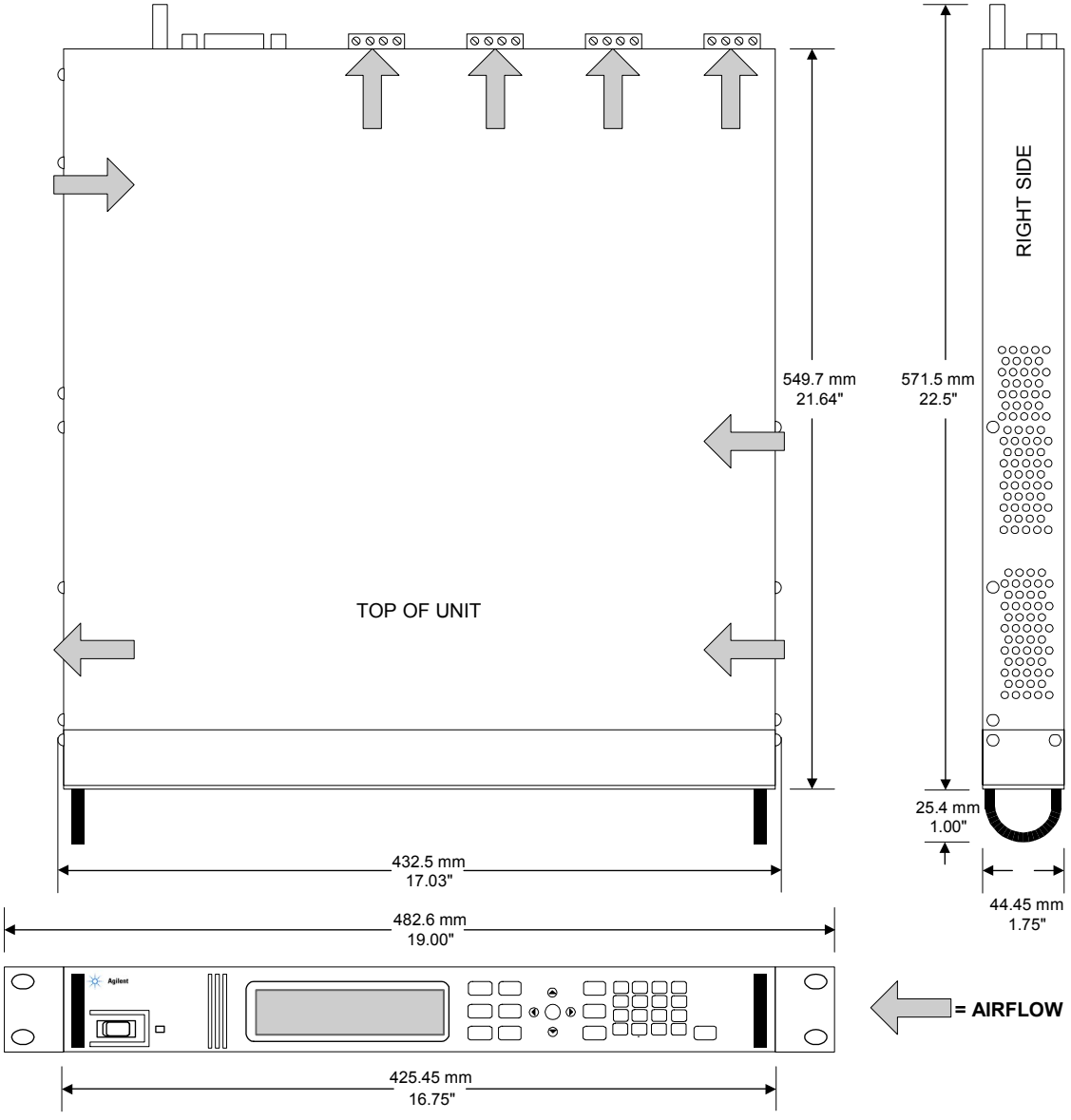
Power Module Option Characteristics

Output Relays (Option 761):	Output Lists (Option 054):	Digitized Measurements (Option 054):
Type = Double-pole, double-throw	Maximum number of steps = 512	Maximum measurement points = 4096
Location = output & sense terminals	Maximum dwell time in seconds = 262	Maximum sample rate = 50 kHz
	Maximum list repetitions = 256, or infinite	

Auto-Ranging Characteristic



Outline Diagram



B
Verification and Calibration

Verification 118
Calibration 133

The verification procedures described in this appendix verify that the power system is operating normally and is within published specifications.

This appendix also includes calibration procedures for the Agilent N6700 MPS. Instructions are given for performing the procedures either from the front panel or from a controller over the GPIB.

NOTE Perform the verification tests before calibrating your power system. If the power system passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.

The recommended calibration interval for Agilent N67xxA DC Power Modules is one year. The Agilent N6700A Mainframe does not require calibration.

Verification

Verification procedures perform two primary functions:

Performance Tests These tests verify that the power system is operating normally and meets the specifications published in Appendix A..

Calibration Tests These tests verify that the power system is operating within its calibration limits.

If the power system fails any of the tests or if abnormal test results are obtained, try calibrating the unit. If calibration is unsuccesful, return the unit to an Agilent Technologies repair facility (see Appendix D).

Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for the calibration and performance tests. A test record sheet may be found at the back of this section.

Type	Specifications	Recommended Model
Digital Voltmeter	Resolution: 10 nV @ 1V; Readout: 8 1/2 digits Accuracy: 20 ppm	Agilent 3458A or equivalent
Current Monitor	15 A (0.1 ohm) 0.04%, TC=5ppm/°C	Guildline 9230/15
Load Resistors	50 Ω, 250 W, 1%, TC<100 ppm/°C (CV noise) 25 Ω, 250 W, 1%, TC<100 ppm/°C (CV noise & calibration) 4 Ω, 250 W, 1%, TC<100 ppm/°C (calibration)	Vishay NH-250-50Ω-1% Vishay NH-250-25Ω-1% Vishay NH-250-4Ω-1%
Electronic Load	20 V, 5 A minimum, with transient capability and a slew rate of 833 kA/s or better.	Agilent N3300A mainframe, with N330xA module
GPIB Controller	Full GPIB capabilities (only required if you are calibrating the unit over the GPIB)	Agilent 82350B or equivalent
Oscilloscope	Sensitivity: 1 mV Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip	Agilent Infiniium or equivalent
RMS Voltmeter	True RMS Bandwidth: 20 MHz Sensitivity: 100 µV	Rhode and Schwartz Model URE3 or equivalent
Differential Amplifier	Bandwidth: 20 MHz	LaCroy 1855A, DA1850A, or equivalent
Terminations	1 – 50 Ω BNC termination 2 – 50 Ω, 1/8 W termination resistors	
Variable-voltage Transformer or AC source	Adjustable to highest rated input voltage range. Power: 500 VA	Agilent 6813B or equivalent

Measurement Techniques

Electronic Load

Many of the test procedures require the use of a variable load capable of dissipating the required power. If a variable resistor is used, switches should be used to either; connect, disconnect, or short the load resistor. For most tests, an electronic load can be used. The electronic load is considerably easier to use than load resistors, but it may not be fast enough to test transient recovery time and may be too noisy for the noise (PARD) tests.

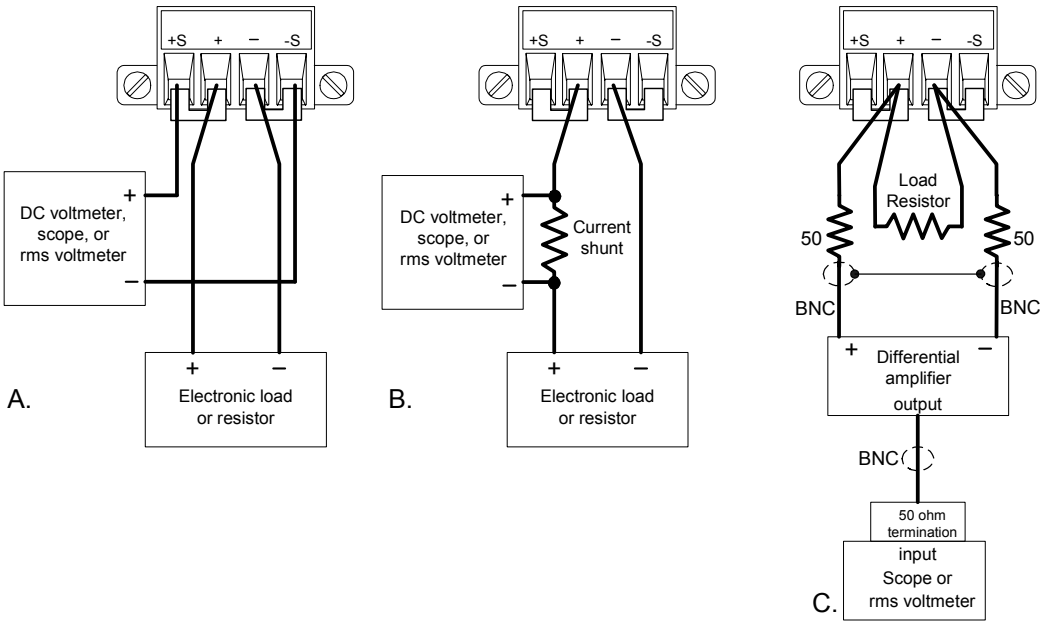
Fixed load resistors may be used in place of a variable load, with minor changes to the test procedures. Also, if computer controlled test setups are used, the relatively slow (compared to computers and system voltmeters) settling times and slew rates of the power system may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the power system.

Current-Monitoring Resistor

The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

Test Set-up

The following figure illustrates the test set-ups used for the verification procedures.



Constant Voltage Tests

NOTE Test each output channel individually. Refer to the appropriate test record form for the instrument settings of the model you are checking.

Voltage Programming and Readback Accuracy

Test category = performance, calibration

This test verifies that the voltage programming and measurement functions are within specifications.

1. Turn off the power system and connect a DVM directly across the sense terminals as shown in Test Setup figure (A). Do not connect a load.
2. Turn on the power system and program the instrument settings as described in the test record form under “Voltage Programming & Readback, Min Voltage” with the load off. The CV annunciator should be on and the output current should be close to zero.
3. Record the output voltage readings on the digital voltmeter (DVM) and the front panel display. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, Min Voltage”.
4. Program the instrument settings as described in the test record form under “Voltage Programming & Readback, High Voltage”.
5. Record the output voltage readings on the DVM and the front panel display. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming and Readback, High Voltage”.
6. *For Agilent Models N6761A and N6762A only.* Repeat steps 4 - 5 for the low voltage range. Program the the instrument settings as described in the test record form under “Voltage Programming & Readback, Low Voltage”. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming and Readback, Low Voltage”.

CV Load Effect

Test category = performance

This test measures the change in output voltage resulting from a change in output current from full load to no load.

1. Turn off the power system and connect a DVM and an electronic load as shown in Test Setup figure (A).
2. Turn on the power system and program the instrument settings as described in the test record form under “CV Load Effect”.
3. Set the electronic load for the output channel’s current as described in the test record form under “CV Load Effect”. The CV annunciator on the front panel must be on. If it isn’t, adjust the load so that the output current drops slightly.
4. Record the output voltage reading from the DVM.

5 Open the load. Record the voltage reading from the DVM again. The difference between the DVM readings in steps 4 and 5 is the load effect, which should not exceed the value listed in the test record form for the appropriate model under “CV Load Effect”.

CV Source Effect

Test category = performance

This test measures the change in output voltage that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

1 Turn off the power system and connect the ac power line through a variable voltage transformer or an AC source.

2 Connect a DVM and an electronic load as shown in Test Setup figure (A). Set the variable voltage transformer or AC source to nominal line voltage.

3 Turn on the power system and program the instrument settings as described in the test record form under “CV Source Effect”.

4 Set the electronic load for the output channel’s current as described in the test record form under “CV Source Effect”. The CV annunciator on the front panel must be on. If it isn’t, adjust the load so that the output current drops slightly.

5 Adjust the transformer or AC source to the lowest rated line voltage (e.g., 104 Vac for a 115 Vac nominal line voltage input).

6 Record the output voltage reading from the DVM.

7 Adjust the transformer or AC source to the highest rated line voltage (e.g., 127 Vac for 115 Vac nominal line voltage input).

8 Record the output voltage reading on the DVM. The difference between the DVM reading in steps 6 and 8 is the source effect, which should not exceed the value listed in the test record form for the appropriate model under “CV Source Effect”.

CV Ripple and Noise

Test category = performance

Periodic and random deviations in the output combine to produce a residual AC voltage superimposed on the DC output voltage. This residual voltage is specified as the rms or peak-to-peak output voltage in the frequency range specified in Appendix A.

1 Turn off the power system and connect the load resistor, differential amplifier, and an oscilloscope (ac coupled) to the output as shown in Test Setup figure (C). Use the 50 Ω load for 50 W outputs; use the 25 Ω load for 100 W outputs.

2 As shown in the diagram, use two BNC cables to connect the differential amplifier to the + and – output terminals. Each cable should be terminated by a 50 Ω resistor. The shields of the two BNC cables should be connected together. Connect the output of the differential amplifier to the oscilloscope with a 50 Ω termination at the input of the oscilloscope.

3 Set the differential amplifier to multiply by ten, divide by one, and 1 Megohm input resistance. The positive and negative inputs of the differential amplifier should be set to AC coupling. Set the oscilloscope's time base to 5 ms/div, and the vertical scale to 10 mV/div. Turn the bandwidth limit on (usually 20 or 30 MHz), and set the sampling mode to peak detect.

4 Program the power supply to the settings indicated in the in the test record form for the appropriate model under "CV Ripple and Noise" and enable the output. Let the oscilloscope run for a few seconds to generate enough measurement points. On the Agilent Infiniium scope, the maximum peak-to-peak voltage measurement is indicated at the bottom of the screen on the right side. Divide this value by 10 to get the CV peak-to-peak noise measurement. The result should not exceed the peak-to-peak limits in the test record form for the appropriate model under "CV Ripple and Noise, peak-to-peak".
(If the measurement contains any question marks, clear the measurement and try again. This means that some of the data received by the scope was questionable.)

5 Disconnect the oscilloscope and connect an rms voltmeter in its place. Do not disconnect the 50 ohm termination. Divide the reading of the rms voltmeter by 10. The result should not exceed the rms limits in the test record form for the appropriate model under "CV Ripple and Noise, rms".

Transient Recovery Time

Test category = performance

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load current.

1 Turn off the power system and connect the output as in Test Setup figure (A) with the oscilloscope across the sense terminals.

2 Turn on the power system and program the program the instrument settings as described in the test record form under "Transient Response".

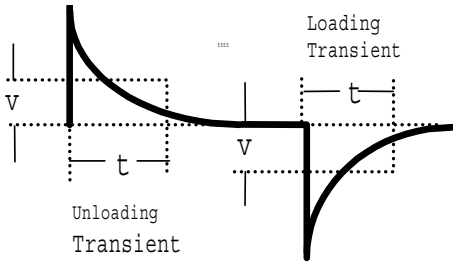
3 Set the electronic load to operate in constant current mode. Program its load current to the lower currrent value indicated in in the test record form under "Transient Response".

4 Set the electronic load's transient generator frequency to 100 Hz and its duty cycle to 50%.

5 Program the load's transient current level to the higher currrent value indicated in in the test record form under "Transient Response", and turn the transient generator on.

6 Adjust the oscilloscope for a waveform similar to that shown in the following figure.

7 The output voltage should return to within the specified voltage at the specified time following the 50% load change. Check both loading and unloading transients by triggering on the positive and negative slope. Record the voltage at time "t" in the performance test record form under "Transient Response".



Constant Current Tests

NOTE Test each output channel individually. Refer to the appropriate test record form for the instrument settings of the model you are checking.

Current Programming and Readback Accuracy

Test category = performance, calibration

This test verifies that the current programming and measurement functions are within specifications.

1. Turn off the power system and connect the current shunt directly across the output terminals. Connect the DVM directly across the current shunt as shown in Test Setup figure (B). Note that the electronic load is not used in this portion of the test.
2. Turn on the power system and program the instrument settings as described in the test record form under “Current Programming & Readback, Min Current”. The CC annunciator should be on and the output voltage reading should be approximately zero.
3. Divide the voltage drop (DVM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout). Also, record the current reading on the front panel display. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming and Readback, Min Current”.
4. Program the instrument settings as described in the test record form under “Current Programming & Readback, High Current”.
5. Divide the voltage drop (DVM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout). Also, record the current reading on the front panel display. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming and Readback, High Current”.
6. *For Agilent Models N6761A and N6762A only.* Repeat steps 4 - 5 for the low current range. Program the instrument settings as described in the test record form under “Current Programming & Readback, Low Current”. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming and Readback, Low Current”.

CC Load Effect

Test category = performance

This test measures the change in output current resulting from a change in output voltage from full scale to short circuit.

1. Turn off the power system and connect the current shunt, DVM, and electronic load as shown in Test Setup figure (B). Connect the DVM directly across the current shunt.
2. To ensure that the values read during this test are not the instantaneous measurement of the AC peaks of the output current ripple, several DC measurements should be made and averaged. If you are using an Agilent 3458A DVM, you can set up the voltmeter to do this automatically. From the instrument's front panel, program 100 power line cycles per measurement. Press NPLC 100 ENTER.
3. Turn on the power system and program the instrument settings as described in the test record form under "CC Load Effect".
4. Set the electronic load for CV mode and program it to the output channel's voltage as described in the test record form under "CC Load Effect". The CC annunciator on the front panel must be on. If it isn't, adjust the load so that the output voltage drops slightly.
5. Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout).
6. Short the electronic load. Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout). The difference in the current readings in steps 4 and 5 is the load effect, which should not exceed the value listed in the test record form for the appropriate model under "CC Load Effect".

CC Source Effect

Test category = performance

This test measures the change in output current that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

1. Turn off the power system and connect the ac power line through a variable voltage transformer or AC source.
2. Connect the current shunt, DVM, and electronic load as shown in Test Setup figure (B). Connect the DVM directly across the current shunt. Set the variable voltage transformer or AC source to nominal line voltage.
3. To ensure that the values read during this test are not the instantaneous measurement of the AC peaks of the output current ripple, several DC measurements should be made and averaged. If you are using an Agilent 3458A DVM, you can set up the voltmeter to do this automatically. From the instrument's front panel, program 100 power line cycles per measurement. Press NPLC 100 ENTER.

4 Turn on the power system and program the instrument settings as described in the test record form under “CC Source Effect”.

5 Set the electronic load for the output channel’s voltage under “CC Source Effect”. The CC annunciator on the front panel must be on. If it isn’t, adjust the load so that the output voltage drops slightly.

6 Adjust the transformer or AC source to the lowest rated line voltage (e.g., 104 Vac for a 115 Vac nominal line voltage input).

7 Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout).

8 Adjust the transformer or AC source to the highest rated line voltage (e.g., 127 Vac for 115 Vac nominal line voltage input).

9 Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout). The difference between the DVM reading in steps 6 and 8 is the source effect, which should not exceed the value listed in the test record form for the appropriate model under “CC Source Effect”.

Test Record Form – Agilent N6751A and N6752A

Agilent N6751A and N6752A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 1 mV	_____	+ 39 mV
Front Panel Display Readback	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	49.951 V	_____	50.049 V
Front Panel Display Readback	Both	Vout – 45 mV	_____	Vout + 45 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 1 mV	_____	+ 1 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 6 mV
rms	Both	N/A	_____	+ 1 mV
Transient Response				
Voltage at 100 µs	Both	– 75 mV	_____	+ 75 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Front Panel Display Readback	Both	Iout – 4 mA	_____	Iout + 4 mA
High Current Iout	N6751A	4.975 A	_____	5.025 A
	N6752A	9.970 A	_____	10.030 A
Front Panel Display Readback	N6751A	Iout – 9 mA	_____	Iout + 9 mA
	N6752A	Iout – 14 mA	_____	Iout + 14 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6751A**	**N6752A**
Voltage Programming & Readback, Min Voltage	20 mV, 5 A	20 mV, 10 A
Voltage Programming & Readback, High Voltage	50 V, 1 A	50 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise	50 V, 1 A	50 V, 2 A
Transient Response	50 V, from 0.5 A to 1 A	50 V, from 1 A to 2 A
Current Programming & Readback, Min Current	10 mA, 50 V	10 mA, 50 V
Current Programming & Readback, High Current	5 A, 10 V	10 A, 8.5 V
CC Load Effect, Source Effect, Ripple and Noise	5 A, 10 V	10 A, 8.5 V

Test Record Form – Agilent N6761A and N6762A

Agilent N6761A and N6762A Description	Report No _____ Model	Minimum Specs.	Date _____ Results	Maximum Specs.
	Constant Voltage Tests			
High Range Voltage Prog. & Readback				
Minimum Voltage Vout	Both	+ 9 mV	_____	+ 21 mV
Front Panel Display Readback	Both	Vout – 6 mV	_____	Vout + 6 mV
High Voltage Vout	Both	49.986 V	_____	50.014 V
Front Panel Display Readback	Both	Vout – 14 mV	_____	Vout + 14 mV
Low Range Voltage Prog. & Readback				
Low Voltage Vout	Both	5.4976 V	_____	5.5024 V
Front Panel Display Readback	Both	Vout – 2.4 mV	_____	Vout + 2.4 mV
CV Load Effect				
	Both	– 0.5 mV	_____	+ 0.5 mV
CV Source Effect				
	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 6 mV
rms	Both	N/A	_____	+ 1 mV
Transient Response				
Voltage at 150 µs	Both	– 75 mV	_____	+ 75 mV
	Constant Current Tests			
High Range Current Prog. & Readback				
Minimum Current Iout	Both	+ 0.8 mA	_____	+ 1.2 mA
Front Panel Display Readback	Both	Iout – 200 µA	_____	Iout + 200 µA
High Current Iout	N6761A	1.4992 A	_____	1.5008 A
	N6762A	2.9986 A	_____	3.0014 A
Front Panel Display Readback	N6761A	Iout – 0.65 mA	_____	Iout + 0.65 mA
	N6762A	Iout – 1.1 mA	_____	Iout + 1.1 mA
Low Range Current Prog. & Readback				
Low Current (Full Scale) Iout	Both	0.099945 A	_____	0.100055 A
Front Panel Display Readback	Both	Iout – 45 µA	_____	Iout + 45 µA
CC Load Effect				
	Both	– 30 µA	_____	+ 30 µA
CC Source Effect				
	Both	– 30 µA	_____	+ 30 µA

	Instrument Settings	
Test Description	**N6761A**	**N6762A.**
Voltage Programming & Readback, Min Voltage	15 mV, 1.5 A	15 mV, 3 A
Voltage Programming & Readback, High Voltage	50 V, 1 A	50 V, 2 A
Voltage Programming & Readback, Low Voltage	5.5 V, 1.5 A	5.5 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise	50 V, 1 A	50 V, 2 A
Transient Response	50 V, from 0.5 A to 1 A	50 V, from 1 A to 2 A
Current Programming & Readback, Min Current	1 mA, 50 V	1 mA, 50 V
Current Programming & Readback, High Current	1.5 A, 33 V	3 A, 33 V
Current Programming & Readback, Low Current	0.1 A, 50 V	0.1 A, 50 V
CC Load Effect, Source Effect, Ripple and Noise	1.5 A, 33 V	3 A, 33 V

Test Record Form – Agilent N6731A

Agilent N6731A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout		+ 1 mV	_____	+ 39 mV
Front Panel Display Readback		Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout		4.976 V	_____	5.024 V
Front Panel Display Readback		Vout – 25 mV	_____	Vout + 25 mV
CV Load Effect				
		– 2 mV	_____	+ 2 mV
CV Source Effect				
		– 1 mV	_____	+ 1 mV
CV Ripple and Noise				
peak-to-peak		N/A	_____	+ 10 mV
rms		N/A	_____	+ 2 mV
Transient Response				
Voltage at 200 µs		– 80 mV	_____	+ 80 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout		– 10 mA	_____	+ 30 mA
Front Panel Display Readback		Iout – 20 mA	_____	Iout + 20 mA
High Current Iout		9.965 A	_____	10.035 A
Front Panel Display Readback		Iout – 35 mA	_____	Iout + 35 mA
CC Load Effect				
		– 2 mA	_____	+ 2 mA
CC Source Effect				
		– 1 mA	_____	+ 1 mA

	Instrument Settings
Test Description	**N6731A**
Voltage Programming & Readback, Zero Voltage	20 mV, 10 A
Voltage Programming & Readback, High Voltage	5 V, 10 A
CV Load Effect, Source Effect, Ripple and Noise	5 V, 10 A
Transient Response	5 V, from 5 A to 10 A
Current Programming & Readback, Zero Current	10 mA, 5 V
Current Programming & Readback, High Current	10 A, 5 V
CC Load Effect, Source Effect	10 A, 5 V

Test Record Form – Agilent N6732A and N6742A

Agilent N6732A and N6742A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 1 mV	_____	+ 39 mV
Front Panel Display Readback	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	7.973 V	_____	8.027 V
Front Panel Display Readback	Both	Vout – 28 mV	_____	Vout + 28 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 12 mV
rms	Both	N/A	_____	+ 2 mV
Transient Response				
Voltage at 200 µs	Both	– 80 mV	_____	+ 80 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Front Panel Display Readback	Both	Iout – 10 mA	_____	Iout + 10 mA
High Current Iout	N6732A	6.22062 A	_____	6.27937 A
	N6742A	9.965 A	_____	10.035 A
Front Panel Display Readback	N6732A	Iout – 19.37 mA	_____	Iout + 19.37 mA
	N6742A	Iout – 25 mA	_____	Iout + 25 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6732A**	**N6742A**
Voltage Programming & Readback, Zero Voltage	20 mV, 6 A	20 mV, 10 A
Voltage Programming & Readback, High Voltage	8 V, 6 A	8 V, 10 A
CV Load Effect, Source Effect, Ripple and Noise	8 V, 6 A	8 V, 10 A
Transient Response	8 V, from 3 A to 6 A	8 V, from 5 A to 10 A
Current Programming & Readback, Zero Current	10 mA, 8 V	10 mA, 8 V
Current Programming & Readback, High Current	6 A, 8 V	10 A, 8 V
CC Load Effect, Source Effect	6 A, 8 V	10 A, 8 V

Test Record Form – Agilent N6733A and N6743A

Agilent N6733A and N6743A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	0 mV	_____	+ 40 mV
Front Panel Display Readback	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	19.96 V	_____	20.04 V
Front Panel Display Readback	Both	Vout – 40 mV	_____	Vout + 40 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 14 mV
rms	Both	N/A	_____	+ 3 mV
Transient Response				
Voltage at 200 µs	Both	– 200 mV	_____	+ 200 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Front Panel Display Readback	Both	Iout – 20 mA	_____	Iout + 20 mA
High Current Iout	N6733A	2.4762 A	_____	2.5237 A
	N6743A	4.9725 A	_____	5.0275 A
Front Panel Display Readback	N6733A	Iout – 8.75 mA	_____	Iout + 8.75 mA
	N6743A	Iout – 12.5 mA	_____	Iout + 12.5 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6733A**	**N6743A**
Voltage Programming & Readback, Zero Voltage	20 mV, 2.5 A	20 mV, 5 A
Voltage Programming & Readback, High Voltage	20 V, 2.5 A	20 V, 5 A
CV Load Effect, Source Effect, Ripple and Noise	20 V, 2.5 A	20 V, 5 A
Transient Response	20 V, from 1.75 A to 2.5 A	50 V, from 1 A to 2 A
Current Programming & Readback, Zero Current	10 mA, 20 V	10 mA, 20 V
Current Programming & Readback, High Current	2.5 A, 20 V	5 A, 20 V
CC Load Effect, Source Effect	2.5 A, 20 V	5 A, 20 V

Test Record Form – Agilent N6734A and N6744A

Agilent N6734A and N6744A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	– 15 mV	_____	+ 55 mV
Front Panel Display Readback	Both	Vout – 35 mV	_____	Vout + 35 mV
High Voltage Vout	Both	34.93 V	_____	35.07 V
Front Panel Display Readback	Both	Vout – 70 mV	_____	Vout + 70 mV
CV Load Effect				
	Both	– 4 mV	_____	+ 4 mV
CV Source Effect				
	Both	– 4 mV	_____	+ 4 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 15 mV
rms	Both	N/A	_____	+ 5 mV
Transient Response				
Voltage at 200 µs	Both	– 200 mV	_____	+ 200 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Front Panel Display Readback	Both	Iout – 4 mA	_____	Iout + 4 mA
High Current Iout	N6734A	1.47775 A	_____	1.52225 A
	N6744A	2.9755 A	_____	3.0245 A
Front Panel Display Readback	N6734A	Iout – 6.25 mA	_____	Iout + 6.25 mA
	N6744A	Iout – 8.5 mA	_____	Iout + 8.5 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6734A**	**N6744A**
Voltage Programming & Readback, Zero Voltage	20 mV, 1 A	20 mV, 3 A
Voltage Programming & Readback, High Voltage	35 V, 1 A	35 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise	35 V, 1 A	35 V, 3 A
Transient Response	35 V, from 0.75 A to 1.5 A	35 V, from 1.5 A to 3 A
Current Programming & Readback, Zero Current	10 mA, 35 V	10 mA, 35 V
Current Programming & Readback, High Current	1.5 A, 35 V	3 A, 35 V
CC Load Effect, Source Effect	1.5 A, 35 V	3 A, 35 V

Test Record Form – Agilent N6735A and N6745A

Agilent N6735A and N6745A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	– 40 mV	_____	+ 80 mV
Front Panel Display Readback	Both	Vout – 60 mV	_____	Vout + 60 mV
High Voltage Vout	Both	49.89 V	_____	50.11 V
Front Panel Display Readback	Both	Vout – 110 mV	_____	Vout + 110 mV
CV Load Effect				
	Both	– 6 mV	_____	+ 6 mV
CV Source Effect				
	Both	– 6 mV	_____	+ 6 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 20 mV
rms	Both	N/A	_____	+ 9 mV
Transient Response				
Voltage at 200 µs	Both	– 200 mV	_____	+ 200 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Front Panel Display Readback	Both	Iout – 4 mA	_____	Iout + 4 mA
High Current Iout	N6735A	0.7788 A	_____	0.8212 A
	N6745A	1.5776 A	_____	1.6224 A
Front Panel Display Readback	N6735A	Iout – 5.2 mA	_____	Iout + 5.2 mA
	N6745A	Iout – 6.4 mA	_____	Iout + 6.4 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6735A**	**N6745A**
Voltage Programming & Readback, Zero Voltage	20 mV, 0.8 A	20 mV, 1.6 A
Voltage Programming & Readback, High Voltage	50 V, 0.8 A	50 V, 1.6 A
CV Load Effect, Source Effect, Ripple and Noise	50 V, 0.8 A	50 V, 1.6 A
Transient Response	50 V, from 0.4 A to 0.8 A	50 V, from 0.8 A to 1.6 A
Current Programming & Readback, Zero Current	10 mA, 50 V	10 mA, 50 V
Current Programming & Readback, High Current	0.8 A, 50 V	1.6 A, 50 V
CC Load Effect, Source Effect	0.8 A, 50 V	1.6 A, 50 V

Calibration

Refer to the "Equipment Required" section in this appendix for a list of the equipment required for calibration. A general outline of the procedure is as follows:

- Enter the calibration mode by providing the correct password. The password is set at the factory to 0 (zero). Once calibration has been entered, the password can be changed by the user. The password must be numeric, and can be up to 15 digits in length. lf the password is incorrect, an error occurs. If the active password is lost, the calibration function can be recovered by setting an internal switch that resets the password to 0. If "Calibration is inhibited by switch setting" appears, the internal switch is set to prevent the calibration from being changed.
- Calibrate only ONE channel at a time. The calibration commands accept only a single channel number for the channel parameter.
- You do not have to do a complete calibration. If appropriate, you may calibrate only the voltage or current functions and then save the calibration constants.
  However, the voltage or current calibration sequence must be performed in the order shown in this appendix in its entirety.
- As each calibration sequence is completed, the instrument calculates new calibration constants and begins using them. However, these constants are not saved in nonvolatile memory until a SAVE command is explicitly given. This can be done after each voltage or current sequence is done, or once after all calibration is complete.
- Exit the calibration mode. Any channels that were calibrated but not saved revert to their previous calibration constants. Note that an *RST command also sets the calibration state to OFF.

Calibration Switches

Two switches control the access to calibration commands. The switches are on the carrier board and are accessible by removing the top cover. Refer to the Disassembly Instructions in Appendix D. Switches 1 and 2 set the calibration configuration as follows:

	Sw 1	Sw 2	Description
Normal	ON	ON	This is the default or as-shipped switch setting. The calibration functions are accessible after entering a numeric password. The default password is 0 (zero).
Clear password	OFF	ON	The calibration password is reset to 0 when the instrument is first powered on. Use this setting if you have forgotten the password.
Inhibit calibration	OFF	OFF	All calibration commands are disabled. This is useful where calibration access is guarded by instrument seals.

Calibration Procedure

Unless instructed otherwise, connect the +sense terminal to the +output, and the -sense terminal to the -output.

When calibrating the unit using SCPI commands, most calibration steps involve sending a *OPC? query to synchronize with the power system's command completion before proceeding. The response from the instrument must be read each time *OPC? is given.

Enable Calibration mode

Front Panel:	SCPI Command:
Select **System\Cal\State**. Enter your password in the Password field and press Select. Select Enable to enable calibration.	`CAL:STAT ON, <password>`

Voltage Programming and Measurement Calibration

Step 1. Connect the DVM's voltage input to an output channel.

Step 2. Select the full-scale voltage programming and measurement range. The following example selects the 50 volt full-scale range of channel 1. The value entered must be the maximum voltage of the range.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\Vprog**. Then select the High range.	`CAL:VOLT 50, (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P1 data	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DVM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P2 data	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DVM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Voltage Programming Calibration

This only applies to Agilent Models N6761A and N6762A.

Step 7. Select the low-voltage programming range. This example selects the 5 volt programming range of channel 1. The value to program a range must be the maximum voltage of the range.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\Vprog**. Then select the Low range.	`CAL:VOLT 5, (@1)`

Step 8. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P1 data	`CAL:LEV P1` `*OPC?`

Step 9. Measure the output voltage with the DVM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done.	`CAL:DATA <data>`

Step 10. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P2 data	`CAL:LEV P2` `*OPC?`

Step 11. Measure the output voltage with the DVM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Voltage Measurement Calibration

This only applies to Agilent Models N6761A and N6762A.

Step 12. Select the low-voltage measurement range. This example selects the 5 volt measurement range of channel 1. The value to program a range must be the maximum voltage of the range.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\Vmeas**.	`CAL:VOLT:MEAS 5, (@1)`

Step 13. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P1 data	`CAL:LEV P1` `*OPC?`

Step 14. Measure the output voltage with the DVM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done.	`CAL:DATA <data>`

Step 15. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P2 data	`CAL:LEV P2` `*OPC?`

Step 16. Measure the output voltage with the DVM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Voltage Common Mode Rejection Ratio Calibration

This only applies to Agilent Models N6751A, N6752A, N6761A and N6762A.

Step 17. For this step only, connect the +sense terminal to the +output and to the –sense terminal. Do not connect the –output terminal. Connect the 25 ohm load resistor across the + and – output terminals (see the equipment list). This procedure is automatic and takes a few seconds.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\CMRR**. Then select Next.	`CAL:VOLT:CMRR (@1)` `*OPC?`

Current Programming and Measurement Calibration

Step 1. Connect a precision shunt resistor to an output channel. Connect the DVM to measure the voltage across the shunt. The shunt resistor should be able to measure at least 120% of the channel's rated full-scale current.

Step 2. Select the full-scale current programming range. The following example selects the 10 amp full-scale current programming and measurement range of channel 1. The value to program a range must be the maximum current of the range.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\Iprog** Then select the High range.	`CAL:CURR 10, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P1 data	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P2 data	`CAL:LEV P2` `*OPC?`

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Current Programming Calibration

This only applies to Agilent Models N6761A and N6762A.

Step 7. Connect a precision shunt resistor to an output channel. Connect the DVM to measure the voltage across the shunt. The shunt resistor should be able to measure at least 120% of the rated output current of this current range.

Step 8. Select the low-current programming range. The following example selects the 0.1 amp low-current programming range of channel 1. The value to program a range must be the maximum current of the range.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\Iprog**. Then select the Low range.	`CAL:CURR 0.1, (@1)`

Step 9. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P1 data	`CAL:LEV P1` `*OPC?`

Step 10. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done.	`CAL:DATA <data>`

Step 11. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P2 data	`CAL:LEV P2` `*OPC?`

Step 12. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Current Measurement Calibration

This only applies to Agilent Models N6761A and N6762A.

Step 13. Remove all loads from the output. Select the low-current measurement range. The following example selects the 0.1 amp low-current measurement range of channel 1. The value to program a range must be the maximum current of the range.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\Imeas**.	`CAL:CURR:MEAS 0.1, (@1)`

Step 14. Re-connect the precision shunt resistor to the output and connect the DVM across the shunt. Select the first current calibration point. Note that in this case, only one calibration point needs to be entered.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter P1 data	`CAL:LEV P1` `*OPC?`

Step 15. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DVM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Current Downprogrammer Calibration

Step 16. Remove all loads from the output. This procedure is automatic and takes a few seconds.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\DPprog**. Then select Next.	`CAL:DPRog (@1)` `*OPC?`

Peak Current Limit Calibration

Steps 17 through 21 only apply to Agilent Models N6751A, N6752A, N6761A and N6762A.

Step 17. Connect the 25 ohm load resistor across the output terminals (see the equipment list).

Step 18. Select peak current limit calibration.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\IPeak**.	`CAL:CURR:PEAK (@1)`

Step 19. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	`CAL:LEV P1` `*OPC?`

Step 20. Replace the 25 ohm resistor with the 4 ohm load resistor (see equipment list).

Step 21. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	`CAL:LEV P2` `*OPC?`

Steps 22 through 24 only apply to Agilent Models N6731A through N6735A, and N6742A through N6745A.

Step 22. Connect the 4 ohm load resistor across the output terminals (see the equipment list).

Step 23. Select peak current limit calibration.

Front Panel:	SCPI Command:
Select **System\Cal\Sequences\IPeak**.	`CAL:CURR:PEAK (@1)`

Step 24. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	`CAL:LEV P1` `*OPC?`

Save and Exit Calibration Mode

CAUTION Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, do not Save the data when you exit the calibration mode. The calibration will then remain unchanged.

Front Panel:	SCPI Command:

Select **System\Cal\Date**.
Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.
Select **System\Cal\Save**. Select Save to save all calibration data.
Select **System\Cal\State**. Select Disable to exit calibration mode.
	To enter a calibration date:
	`CAL:DATE "<date>", (@1)`
	To save calibration data:
	`CAL:SAVE`
	To exit calibration mode:
	`CAL:STAT OFF`

Change the Calibration Password

Front Panel:	SCPI Command:

Select **System\Cal\State**.
Enter the original password in the Password field and press Select.
Select Enable to enable calibration.
Select **System\Cal\Password**. Enter a new password in the Password field.
Select **System\Cal\State**. Select Disable to exit calibration mode.
	Enter calibration mode using the original password
	`CAL:STAT ON, <password>`
	To change the password:
	`CAL:PASS <NRf>`
	To exit calibration mode:
	`CAL:STAT OFF`

C
Using the Digital Port

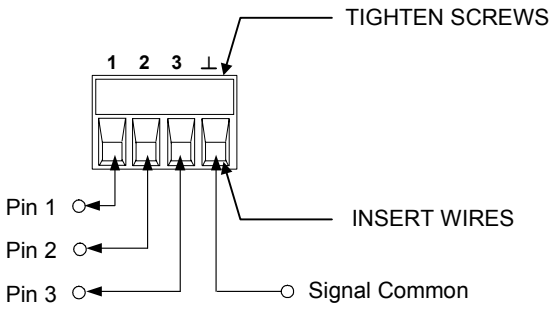
Digital Control Port 144
Configuring the Digital Control Port 148

A Digital Control Port consisting of three I/O pins is provided to access various control functions. Each pin is user-configurable. The following control functions are available for the I/O pins:

- External Trigger
- Fault Output
- Inhibit Input
- Bi-directional Digital I/O
- Digital Input only

Digital Control Port

A 4-pin connector and a quick-disconnect connector plug are provided on each instrument for accessing the five digital control port functions.



The digital control connector accepts wires sizes from AWG 14 to AWG 30. Note that wire sizes smaller than AWG 24 are not recommended. Disconnect the connector plug to make your wire connections.

NOTE It is good engineering practice to twist and shield all signal wires to and from the digital connectors. If shielded wire is used, connect only one end of the shield to chassis ground to prevent ground loops.

The following chart describes the possible pin configuration for the available control functions. For a complete description of the electrical characteristics of the digital I/O port, refer to Appendix A.

Pin	External Trigger	Fault/Inhibit	Digital I/O
1	Trigger In/Out	FLT Output	Input/Output 0
2	Trigger In/Out	FLT Common	Input/Output 1
3	Trigger In/Out	INH Input	Input/Output 2
⊥	Trigger Common	INH Common	Signal Common

In addition to the configurable pin functions, the active signal polarity for each pin is also configurable. When Positive polarity is selected, a logical true signal is a voltage high at the pin. When negative polarity is selected, a logical true signal is a voltage low at the pin.

External Trigger

Any of the Digital Control pins can be programmed to function either as trigger inputs or trigger outputs. All three pins are referenced to the Signal Common pin.

To input an external trigger signal, you can either apply a negative-or a positive-going pulse to the designated trigger input pin. The trigger latency is 5 microseconds. The minimum pulse width is 1 microsecond. The pin's polarity setting determines which edge generates a trigger-in event.

When configured as a trigger output, the designated trigger pin will generate a 2 microsecond-wide trigger pulse in response to a trigger event. Depending on the polarity setting, it can be either positive-going or negative-going when referenced to common.

Fault Output

The Fault Output function enables a fault condition on any channel to generate a fault signal on the Digital Control port. The following conditions will generate a fault event: over-voltage, over-current, over-temperature, inhibit signal, and power-fail (low AC-line).

When this function is selected, both pins 1 and 2 are dedicated to this function. Pin 1 is the Fault output; pin 2 is common for pin 1. This arrangement provides an optically-isolated output. Pin 2's selected function is ignored. Note that the Fault output signal remains latched until the fault condition is cleared. You must also clear the protection circuit.

Inhibit Input

The Inhibit Input function lets an external input signal control the output state of all of the output channels in the mainframe. The signal latency is 5 microseconds. The Inhibit function is only available on pin 3. Pin 4 is common for pin 3. Pin 3 can be programmed for the following Inhibit modes:

LATChing Causes a logic-true transition on the Inhibit input to disable all outputs.

LIVE Allows the enabled outputs to follow the state of the Inhibit input. When the Inhibit input is true, the outputs are disabled. When the Inhibit input is false, the outputs are re-enabled.

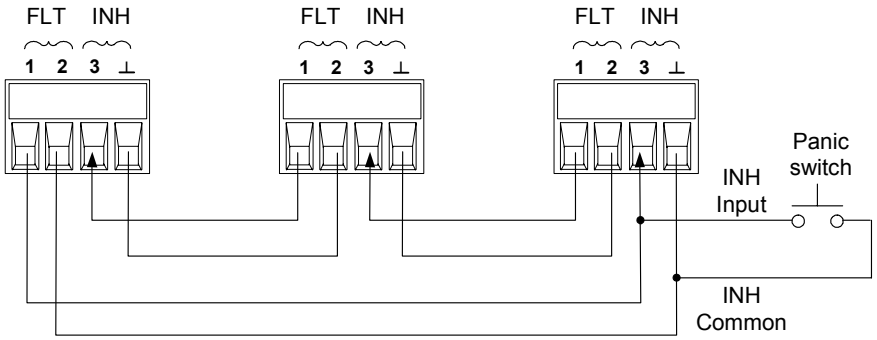
OFF The Inhibit input is ignored.

Output channels can only be controlled by the inhibit signal if they have previously been turned on by the OUTPut:STATe command or by the front panel On/Off switch. If an output channel has been turned off, it cannot be controlled by the Inhibit signal.

When an Inhibit signal turns off the outputs, the front panel INH status annunciator comes on and the INH bit is set in the Questionable Status Event register. To re-enable the outputs if the inhibit signal was latched, you must clear the protection circuit.

Fault/Inhibit System Protection

The following figure illustrates some ways that you can connect the Fault/Inhibit pins of the connector.



As shown in the previous figure, when the Fault outputs and Inhibit inputs of several mainframes are daisy-chained, an internal fault condition in one of the mainframes will disable all of them without intervention either by the controller or external circuitry.

You can also connect the Inhibit input to a manual switch that will short the Inhibit pin to common whenever it is necessary to disable all output channels in the mainframe. You can also use the Fault output to drive an external relay circuit or signal other devices whenever a user-definable fault occurs.

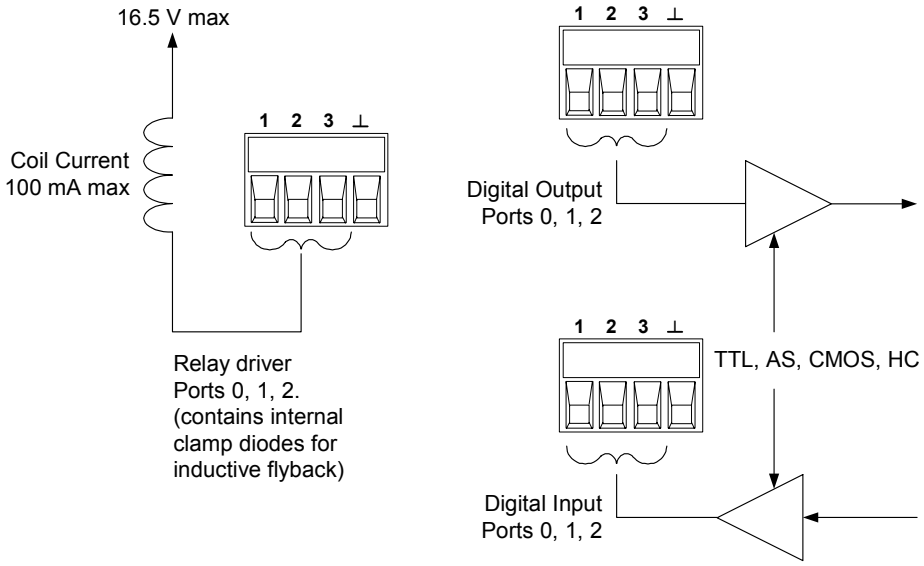
Bi-directional Digital I/O

When the Digital Control pins are configured for bi-directional digital I/O, the pins function as a bi-directional input/outputs, the state of which can be controlled and read at all times. The ground reference for the I/O pin is Signal Common on pin 4. The DIGital:OUTPut:DATA command controls the state of the output pins, and the DIGital:OUTPut:DATA? query reads the state of the pins according to the following bit assignments:

Pin	Bit
1	0
2	1
3	2

The input/output pin can be used to control both relay circuits as well as digital interface circuits. The following figure illustrates typical relay circuits as well as digital interface circuit connections using the Digital I/O functions.

For a complete description of the electrical characteristics of the digital I/O port, see Appendix A.



A) Relay Circuits **B) Digital Interface Circuits**

Digital Input Only

When an I/O pin is configured for Digital Input only, the pin functions as a digital input pin. The ground reference for the I/O pin is Signal Common on pin 4.

The pin status reflects the true condition of the external signal that is applied to the pin. The pin state is not affected by the value of the digital output word.

Configuring the Digital Control Port

You can configure the Digital Control pins to perform five different functions. These pins can be programmed either from the front panel or using SCPI commnds.

External Trigger

Each of the three pins can be configured as either trigger inputs or trigger outputs. The polarity of the pins can also be configured. When you program trigger polarity, POSitive means a rising edge and NEGative means a falling edge.

Front Panel:	SCPI Command:

Select **System\DigPort**, then either Pin 1, Pin2, or Pin 3.
Select Function and configure the pin as TrigIn or TrigOut.
Go back one level, select Polarity, then either Positive or Negative.
	To select the trigger output function for pin 1:
	`DIG:PIN1:FUNC TOUT`
	To select the trigger input function for pin 2:
	`DIG:PIN2:FUNC TINP`
	To select the trigger polarity:
	`DIG:PIN<#>:POL <pol>`

Fault Output

Pins 1 and 2 can be configured as a fault-output pair. The polarity of pin 1 can also be configured.

Front Panel:	SCPI Command:

Select **System\DigPort\Pin1**.
Select Function and configure the pin as FaultOut.
Go back one level, select Polarity, then either Positive or Negative.
	To configure the Fault function:
	`DIG:PIN1:FUNC FAUL`
	To select the fault output polarity:
	`DIG:PIN1:POL <pol>`

Inhibit Input

Pin 3 can be configured as a remote inhibit input. The polarity of pin 3 can also be configured.

Front Panel:	SCPI Command:

Select **System\DigPort\Pin3**.
Select Function and configure the pin as InhibitIn.
Go back one level, select Polarity, then either Positive or Negative.
	To configure the Inhibit function:
	`DIG:PIN3:FUNC INH`
	To select the inhibit input polarity:
	`DIG:PIN3:POL <pol>`

After you have configured pin 3 as the remote inhibit input, you must also configure the operating mode of the Inhibit signal. The inhibit signal can be latched or live. When latched, the outputs will remain disabled after an inhibit signal is received. When live, the outputs will follow the state of the Inhibit input. The Inhibit operating mode is stored in non-volatile memory.

Front Panel:	SCPI Command:

Select **Protection/Inhibit**.
Select either Latching or Live.
To disable Inhibit, select Off
	To latch the Inhibit signal:
	`OUTP:INH:MODE LATC`
	To set the Inhibit signal live:
	`OUTP:INH:MODE LIVE`
	To disable the Inhibit signal:
	`OUTP:INH:MODE OFF`

Digital I/O

Each of the three pins can be configured as general-purpose digital inputs and outputs. The polarity of the pins can also be configured.

Front Panel:	SCPI Command:

Select **System\DigPort**, then either Pin 1, Pin2, or Pin 3.
Select Function and configure the pin as DigIO.
Go back one level, select Polarity, then either Positive or Negative.
To send digital data to the pins, select **System\DigPort\Data**.
Select DataOut and enter the data.
	To configure the pin function:
	`DIG:PIN<#>:FUNC DIO`
	To configure pin polarity:
	`DIG:PIN<#>:POL <pol>`
	To send data to the pins:
	`DIG:OUTP:DATA <data>`

Digital Input

Each of the three pins can be configured as digital input only. The polarity of the pins can also be configured.

Front Panel:	SCPI Command:

Select **System\DigPort**, then either Pin 1, Pin2, or Pin 3.
Select Function and configure the pin as DigIn.
Go back one level, select Polarity, then either Positive or Negative.
To read the data from the pins, select **System\DigPort\Data**.
Select DataIn and read the data.
	To configure the pin function:
	`DIG:PIN<#>:FUNC DINP`
	To configure pin polarity:
	`DIG:PIN<#>:POL <pol>`
	To read the pin data:
	`DIG:INP:DATA?`

D
Service

Types of Service Available 152
Operating Checklist 152
Repackaging for Shipment 152
Disassembly 153
Error Messages 156

This chapter discusses the procedures involved for returning a failed instrument to Agilent Technologies for service or repair. Actual repair is done through unit exchange.

Types of Service Available

If your instrument fails during the warranty period (see “Warranty”), Agilent Technologies will replace or repair it free of charge. After your warranty expires, Agilent Technologies will replace or repair it at a competitive price. The standard repair process is “whole unit exchange”. The replacement units are fully refurbished and are shipped with new calibration certificates.

Contact your nearest Agilent Technologies Service Center. They will arrange to have your instrument repaired or replaced.

Operating Checklist

Before returning your instrument to Agilent Technologies for service or repair, check the following items:

Is the instrument inoperative?

- Verify that the ac power cord is connected to the instrument.
- Verify that the front-panel On/Standby switch has been pushed.

Is the display working?

- If the display is hard to read, but front-panel LED is lit and the fans are working, the display contrast setting may be too light or too dark. Use the front panel menu to set the display contrast.

Does the instrument fail self-test?

- Remove all external connections to the instrument.
- Check that modules are installed next to each other, starting with slot 1. If there are any empty slots (or filler modules) *between* the power modules, the power system will not operate.
- Turn off the unit and cycle power to run self-test again.

Repackaging for Shipment

If the unit is to be shipped to Agilent Technologies for service or repair, be sure to:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model and serial number.
- Place the unit in its original container with the appropriate packaging material and secure the container with strong tape or metal bands.

If the original shipping container is not available, place your unit in a container that will ensure at least 4 inches of compressible packaging material around all sides for the instrument. Use static-free packaging materials to avoid additional damage to your unit.

Agilent Technologies suggests that you always insure shipments.

Disassembly

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 volts. The following guidelines will help prevent ESD damage when servicing the instrument or any electronic device.

- Disassemble instruments *only* in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.

Required Tools

For the disassembly procedures in this manual, the following tools are required:

- T10 Torx driver - to remove or install modules in the mainframe
- T25 Torx driver – remove a mainframe from the equipment rack.

Removing/Installing Modules

WARNING **SHOCK HAZARD. FAN HAZARD. Turn off the mainframe and disconnect its power cord before attempting any of the following procedures.**

CAUTION Modules must be installed next to one another, starting with slot 1. Do not leave any empty slots *between* modules, otherwise the power system will not operate. Any remaining unused slots must have a filler module installed to ensure proper cooling. Do not install filler modules *between* power modules.

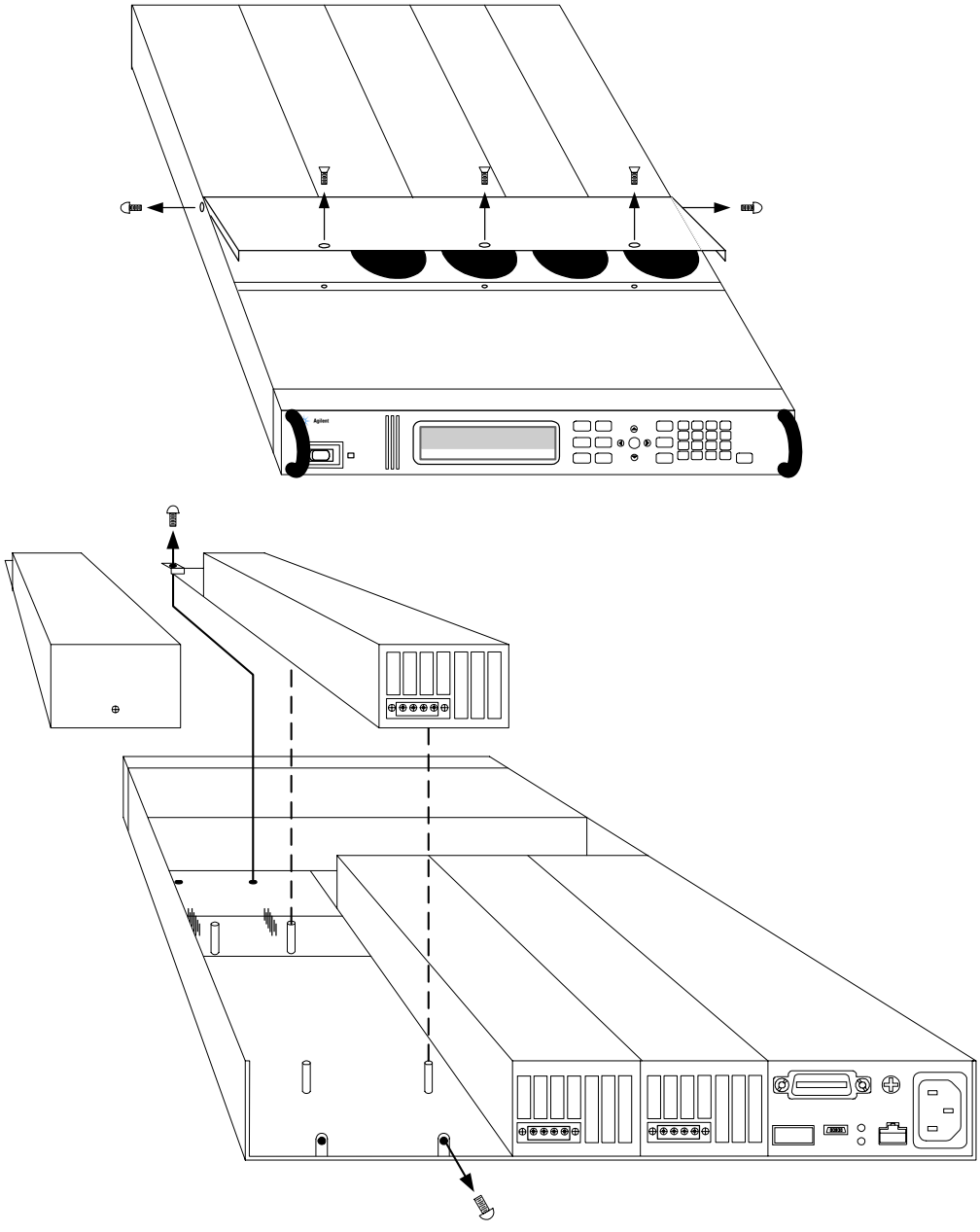
Step 1. Remove the blower cover. Remove three screws from the top of the cover and two screws on the sides. Tilt the cover up and slide it out.

Step 2. To remove a module, first remove the two fastening screws at either end of the module. Grasp the module at the ends (near the fan and the output connector), and lift it straight up out of the mainframe.

Step 3. To install a module, align the module over the alignment pins, and push it down onto the mainframe connector. Filler modules install in the same manner as power modules.

Step 4. Fasten the module to the mainframe. Use the two screws from the power module or filler module and install them at either end of the module.

Step 5. Replace the blower cover when finished. Be careful not to bend the RFI clips on the edge of the cover when sliding it under the lip of the the output modules.



Accessing the Calibration switch

WARNING **SHOCK HAZARD. FAN HAZARD. Turn off the mainframe and disconnect its power cord before attempting any of the following procedures.**

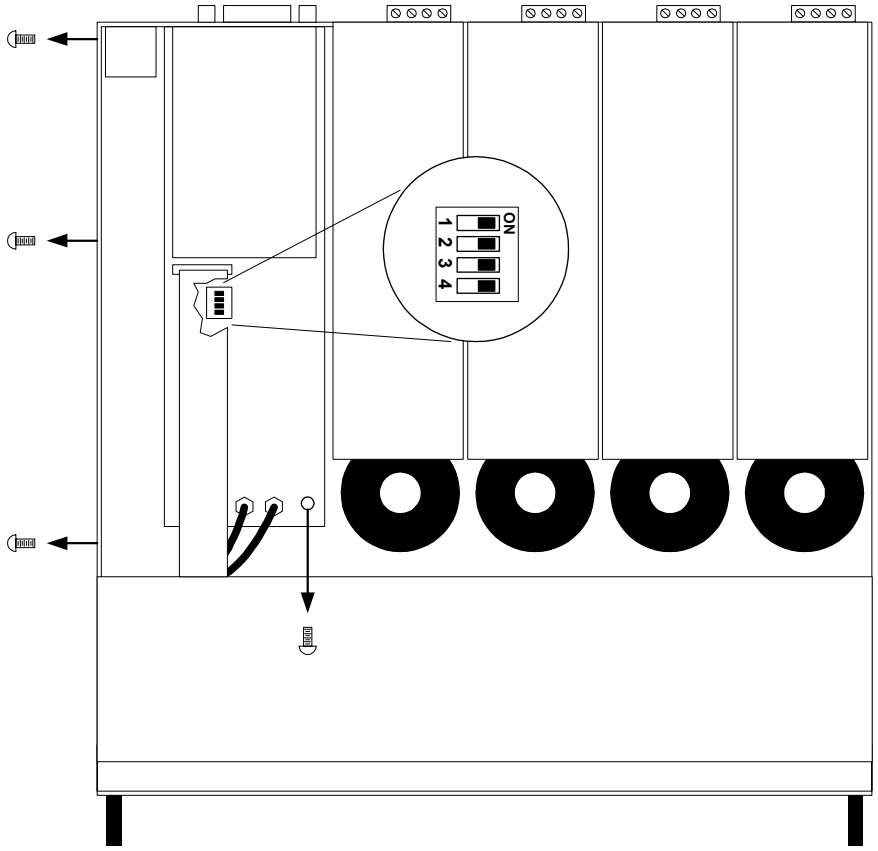
Step 1. Remove the blower cover (cover is shown in the previous figure). Remove three screws from the top of the cover and two screws on the sides. Tilt the cover up and slide it out.

Step 2. Remove the GPIB/carrier board cover. Remove the three screws along the side of the unit counting from the rear panel. Then remove the screw at the end of the carrier board that attaches the cover to the board (refer to the following figure). Lift off the cover.

Step 3. The calibration switch is located under the ribbon cable close to the GPIB board. Change the calibration switch settings. Use a small screwdriver to move the switches. Refer to Appendix B for settings information.

CAUTION Do not use a pencil to move the switches. Any graphite dust that gets on the switches will conduct electricity.

Step 4. Replace the GPIB/carrier and the blower covers when finished. Be careful not to bend the RFI clips on the edge of the blower cover when sliding it under the lip of the the output modules.



Error Messages

Displaying the SCPI error queue

Front Panel:	SCPI Command:
Press the Error key. If errors appear, use the navigation keys to scroll though the list.	`SYST:ERR?`

The entire error queue is read, then emptied.

Error List

The following table documents the various error messages that the power system supports:

Error	**Device-dependent Errors** (these errors set Standard Event Status register bit #3)
0	**No error** This is the response to the ERR? query when there are no errors.
100	**Too many channels** You have specified more channels than are installed in the mainframe.
101	**Calibration state is off** Calibration is not enabled. The instrument will not accept calibration commands.
102	**Calibration password is incorrect** The calibration password is incorrect.
103	**Calibration is inhibited by switch setting** Calibration mode is locked out by the calibration switch.
104	**Bad sequence of calibration commands** Calibration commands have not been entered in the proper sequence.
105	**Unexpected output current** The measured output current is outside the acceptable range.
106	**Zero measurement out of range error** The “zero” measurement value is outside the acceptable range.
107	**Programming cal constants out of range** The programmed calibration constant is outside the acceptable range.
108	**Measurement cal constants out of range** The measurement calibration constant is outside the acceptable range.
109	**Over voltage cal constants out of range** The over voltage calibration constant is outside the acceptable range.
110	**Wrong V+I** The instrument was unable to set the correct voltage or current value.
111	**Aux vloc cal constants out of range** Calibration constants on the internal auxiliary local ADC are outside the acceptable range.
112	**Aux vrem cal constants out of range** Calibration constants on the internal auxiliary remote ADC are outside the acceptable range.
113	**Aux imon cal constants out of range** Calibration constants on the internal auxiliary imon ADC are outside the acceptable range.

	Device-dependent Errors (continued)
200	**Hardware error channel <channel>** A hardware error has occurred on the specified channel.
201	**Invalid configuration, empty slots** There is an empty slot between modules. This configuration is not allowed.
202	**Selftest Fail** A selftest failure has occurred. See selftest failure list for details.
203	**Compatibility function not implemented** The requested compatibility function is not available.
204	**NVRAM checksum error** A checksum error has occurred in the instrument's nonvolatile random access memory.
205	**NVRAM full** The nonvolatile random access memory of the instrument is full.
206	**File not found** The internal calibration file or the internal channel attribute file was not found in NVRAM.
207	**Cal file version error** The calibration file was written or read using old firmware. Firmware must be updated.
302	**Option not installed** The option that is programmed by this command is not installed.
303	**There is not a valid acquisition to fetch from** There is no valid data in the measurement buffer.
304	**Volt and curr in incompatible transient modes** Voltage and current cannot be in Step and List mode at the same time.
305	**A triggered value is on a different range** A triggered value is on a different range than the one that is presently set.
306	**Too many list points** Too many list points have been specified.
307	**List lengths are not equivalent** One or more lists are not the same length.
308	**This setting cannot be changed while transient trigger is initiated** Setting cannot be changed while the instrument is waiting for or executing a trigger sequence.
309	**Cannot initiate, voltage and current in fixed mode** Cannot initiate the transient generator because either the voltage or the current function is set to Fixed mode.

	Command Errors (these errors set Standard Event Status register bit #5)
–100	**Command error** Generic syntax error.
–101	**Invalid character** An invalid character was found in the command string.
–102	**Syntax error** Invalid syntax was found in the command string. Check for blank spaces.
–103	**Invalid separator** An invalid separator was found in the command string. Check for proper use of , ; :
–104	**Data type error** A different data type than the one allowed was found in the command string.
–105	**GET not allowed** A group execute trigger is not allowed in a command string.

	Command Errors (continued)
–108	**Parameter not allowed** More parameters were received than were expected.
–109	**Missing parameter** Fewer parameters were received than were expected.
–110	**Command header error** An error was detected in the header.
–111	**Header separator error** A character that was not a valid header separator was found in the command string.
–112	**Program mnemonic too long** The header contains more than 12 characters.
–113	**Undefined header** A command was received that was not valid for this instrument.
–114	**Header suffix out of range** The value of the numeric suffix is not valid.
–120	**Numeric data error** Generic numeric data error.
–121	**Invalid character in number** An invalid character for the data type was found in the command string.
–123	**Exponent too large** The magnitude of the exponent was larger than 32000.
–124	**Too many digits** The mantissa of a numeric parameter contained more than 255 digits, excluding leading zeros.
–128	**Numeric data not allowed** A numeric parameter was received but a character string was expected.
–130	**Suffix error** Generic suffix error
–131	**Invalid suffix** A suffix was incorrectly specified for a numeric parameter.
–134	**Suffix too long** The suffix contains more than 12 characters.
–138	**Suffix not allowed** A suffix is not supported for this command.
–140	**Character data error** Generic character data error
–141	**Invalid character data** Either the character data element contains an invalid character, or the element is not valid.
–144	**Character data too long** The character data element contains more than 12 characters.
–148	**Character data not allowed** A discrete parameter was received, but a string or numeric parameter was expected.
–150	**String data error** Generic string data error
–151	**Invalid string data** An invalid character string was received. Check that the string is enclosed in quotation marks.
–158	**String data not allowed** A character string was received, but is not allowed for this command.

	Command Errors (continued)
–160	**Block data error** Generic block data error
–161	**Invalid block data** The number of data bytes sent does not match the number of bytes specified in the header.
–168	**Block data not allowed** Data was sent in arbitrary block format but is not allowed for this command.
–170	**Expression error** Generic expression error
–171	**Invalid expression data** The expression data element was invalid.
–178	**Expression data not allowed** Expression data element was sent but is not allowed for this command.

	Execution Errors (these errors set Standard Event Status register bit #4)
–200	**Execution error** Generic syntax error
–220	**Parameter error** A data element related error occurred.
–221	**Settings conflict** A data element could not be executed because of the present instrument state.
–222	**Data out of range** A data element could not be executed because the value was outside the valid range.
–223	**Too much data** A data element was received that contains more data than the instrument can handle.
–224	**Illegal parameter value** An exact value was expected but not received.
–225	**Out of memory** The device has insufficient memory to perform the requested operation.
–226	**Lists not same length** One or more lists are not the same length.
–230	**Data corrupt or stale** Possible invalid data. A new reading was started but not completed.
–231	**Data questionable** The measurement accuracy is suspect.
–232	**Invalid format** The data format or structure is inappropriate.
–233	**Invalid version** The version of the data format is incorrect to the instrument.
–240	**Hardware error** The command could not be executed because of a hardware problem with the instrument.
–241	**Hardware missing** The command could not be executed because of missing hardware, such as an option.
–260	**Expression error** An expression program data element related error occurred.
–261	**Math error in expression** An expression program data element could not be executed due to a math error.

	Query Errors (these errors set Standard Event Status register bit #2)
–400	**Query Error** Generic error query
–410	**Query INTERRUPTED** A condition causing an interrupted query error occurred.
–420	**Query UNTERMINATED** A condition causing an unterminated query error occurred.
–430	**Query DEADLOCKED** A condition causing a deadlocked query error occurred.
–440	**Query UNTERMINATED after indefinite response** A query was received in the same program message after a query indicating an indefinite response was executed.

	Selftest Errors (these errors set Standard Event Status register bit #3)
202	**Selftest Fail Aux Adc 0 expected <n1> to <n2>, measured <n3>, chan <n4>** Auxiliary ADC failed. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 0 expected <n1> to <n2>, measured <n3>, chan <n4>** Both voltage and current DACs are at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 1 expected <n1> to <n2>, measured <n3>, chan <n4>** Voltage DAC is at zero; current DAC is at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 2 expected <n1> to <n2>, measured <n3>, chan <n4>** Voltage DAC is at full scale; current DAC is at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 3 expected <n1> to <n2>, measured <n3>, chan <n4>** Both voltage and current DACs are at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

E
Compatibility

Differences – In General 162
Compatibility Command Summary 163

The Agilent N6700 MPS is programmatically compatible with the Agilent 6621A – 6629A DC power supplies. This means that you can program the power system using the same commands that are used to program the Agilent 662xA power supplies. The following table describes the model mapping.

In addition to the pre-configured models listed below, Agilent 662xA commands will also work in mainframes that contain any combination of N675xA or N675xA power modules.

NOTE Agilent 662xA commands will NOT work in mainframes that contain any Agilent of N673xA or N674xA power modules. This is true even if the mainframes also contain Agilent N675xA or N676xA power modules.

Pre-configured Agilent MPS Model	Description	Previous Agilent Model
N6721A	N6700A Mainframe with 2 – N6752A autoranging modules	6621A
N6722A	N6700A Mainframe with 2 – N6752A autoranging modules	6622A
N6723A	N6700A Mainframe with 2 – N6751A and 1 – N6752A autoranging module	6623A
N6724A	N6700A Mainframe with 4 – N6751A autoranging modules	6624A
N6725A	N6700A Mainframe with 1 – N6761A and 1 – N6762A precision module	6625A
N6726A	N6700A Mainframe with 2 – N6761A and 2 – N6762A precision modules	6626A
N6727A	N6700A Mainframe with 4 – N6751A autoranging modules	6627A
N6728A	N6700A Mainframe with 2 – N6762A precision modules	6628A
N6729A	N6700A Mainframe with 4 – N6762A precision modules	6629A

Differences – In General

The following table documents the general differences between the way the Compatibility programming commands work on the Agilent N6700 MPS and the way they work on the Agilent 662xA series DC power supplies.

Item	Differences
Queries	The Agilent N672xA models will respond to multiple queries. It will not allow a space separator between numbers. It will not allow a user to query information, read back only a portion of the information, send another command, and finish reading back the information from the original query. Sending a second query without reading the response to the first will generate an error. Model number queries will only return the N6700A model number.
Status functions	Serial Poll will be controlled by the SCPI status model and will not act like a 662xA serial poll. SRQ will be controlled by the SCPI status model. Parallel poll will not work. The Agilent N67xxA modules will never set the CC- bit. All other status bits are translated to the closest 662xA bits.
Settings	The full-scale limits will match the Agilent N67xxA module limits. There is no automatic setting adjustment.
Measurement	Measurements use the present settings for points, time interval, etc. Floating point numbers returned by the instrument may not have exactly the same syntax or number of digits.
Calibration	Calibration must be done in SCPI.
Storage states	The Agilent N67xxA modules have 2 non-volatile states and 9 volatile states. The 9 volatile states are only available when using compatibility commands.
Protection functions	OVRST and OCRST will reset all latched protection functions, not just over-voltage or over-current.

Compatibility Command Summary

The following table documents the compatibility commands that the Agilent N6700 MPS supports. All compatibility commands are accepted; however, some commands will generate an error.

Agilent 662xA Command	Description	Similar SCPI Command
ASTS? <ch>	Queries the accumulated status (ASTS) of the specified output channel. The response represents the sum of the binary weights of the ASTS register bits. The ASTS register is automatically set to the present status after being queried.	STAT:OPER:EVEN? STAT:QUES:EVEN? *ESE?
CLR	Returns the entire power system (all outputs) to the power-on state, except the unit is not unaddressed and its store/recall registers are not changed.	*RST
CMODE <on/off>	Generates error –113. The unit must be calibrated using SCPI commands.	see Appendix B
CMODE?	Generates error –113. The unit must be calibrated using SCPI commands.	see Appendix B
DC <ch>, < on/off >	Turns the specified output channel on or off. On/off = 0 turns the channel off; on/off = 1 turns the channel on.	OUTP:STAT
DC? <ch>	Queries whether the specified output channel is on or off. Response is either 1 (on) or 0 (off).	OUTP:STAT?
DCPON < on/off >	Sets the power-on state of the output channels. For on/off = 0, all outputs will be off state when the unit is turned on. For on/off = 1 all outputs will be in the on state when the power system is turned on. This command requires the output power-on state to be set to RCL0.	OUTP:PON:STAT RCL0
DCPON?	Returns a 1 if any channels are set to turn on their output at power on.	OUTP:PON:STAT?
DLY <ch>, <delay>	Sets the reprogramming delay for the specified output channel. This delay is used to mask the CV, CC, CP-, UNR, and other status bits from the fault register and the OCP function for the specified delay period.	OUTP:PROT:DEL
DLY? <ch>	Queries the present reprogramming delay of the specified output channel.	OUTP:PROT:DEL?
DSP <on/off>	Does nothing.	None
DSP?	Always returns a 1.	None
DSP " xxxxxxxxxxx"	Does nothing.	None
ERR?	Queries the present programming or hardware error. An error code number is returned over the GPIB to identify the error.	SYST:ERR?
FAULT? <ch>	Queries the fault register of the specified output channel. A bit is set in the fault register when the corresponding bit in both the status and the mask registers. The response is an integer 0 to 255. The fault register is cleared after being read.	STAT:OPER? STAT:QUES? *ESE?
ID?	Queries the model number of the power system.	*IDN?
IDATA <ch>, <Ilo>, <Ihi>	Generates error –113. Unit must be calibrated using SCPI commands.	see Appendix B

Agilent 662xA Command	Description	Similar SCPI Command
IHI <ch>	Generates error –113. Unit must be calibrated using SCPI commands.	see Appendix B
ILO <ch>	Generates error –113. Unit must be calibrated using SCPI commands.	see Appendix B
IOUT? <ch>	Queries the measured output current of the specified output channel. The response is a real number. The front panel display can be used to monitor the measured output current (and voltage) of the selected output channel.	MEAS:CURR?
IRLO <ch>	Generates error –113.	None
IRHI <ch>	Generates error –113.	None
IRLN <ch>	Generates error –113.	None
IRHN <ch>	Generates error –113.	None
IRSET <ch>, <x>	Sets the full-scale current range programming for an output channel. The power system will select the lowest operating range that will contain the value (x). If the present operating current is greater than the full-scale range selected, the present output current will be reduced to the full-scale value of the new range selected. If the current entered is larger than the highest possible range, an error will result.	SENS:CURR:RANG
IRSET? <ch>	Queries the full-scale current range setting of an output channel.	SENS:CURR:RANG?
ISET <ch>, <current>	Sets the current of the specified output channel.	CURR
ISET? <ch>	Queries the present current setting of the specified output channel. The response is a real number.	CURR?
ISTEP <ch>, <x>	Increases or decreases the output channel current in steps. If the step value < x > is positive, output current will increase by the step value, if the step value is negative, the output current will decrease by the step value. Stepping beyond the active operating range causes an error.	LIST:CURR
METER <ch>	Does nothing.	None
METER?	Always returns a 1.	None
OCP <ch>, <on/off>	Enables the over-current protection circuit for the specified output channel. This circuit, when enabled, causes the output to go to the off state when the output is in + CC mode. On/off is a 1 to turn on (enable) or a 0 to turn off (disable) the circuit.	CURR:PROT:STAT
OCP? < ch >	Queries the over-current protection circuit on/off status for the specified output channel. Response is either a 1 (on) or a 0 (off).	CURR:PROT:STAT?
OCRST < ch >	Returns the specified output channel to its previous settings after it has been turned off by a protection shutdown.	OUTP:PROT:CLE
OUT < ch >, < on/off >	Turns the specified output channel on or off. <on/off> equals 1 to turn the output on and equals 0 to turn the output off.	OUTP
OUT? < ch >	Queries whether the specified output channel is turned on or off . The response is either 1 (on) *or* 0 (off).	OUTP?

Agilent 662xA Command	Description	Similar SCPI Command
OVCAL < ch >	Generates error –113. Unit must be calibrated using SCPI commands.	see Appendix B
OVRST < ch >	Returns the specified output channel to its previous settings after it has been turned off by a protection shutdown.	OUTP:PROT:CLE
OVSET <ch>, <ovpoint>	Sets the over-voltage trip point for the specified output channel.	VOLT:PROT:LEV
OVSET? < ch >	Queries the present over-voltage setting of the specified output channel. The response is a real number.	VOLT:PROT:LEV?
PON < on/off >	Does nothing.	*SRE
PON?	Always returns a 0.	*SRE?
RCL < reg >	Recalls the settings for all output channels from the specified internal register. These settings were previously stored using the STO command. RCL programs all output channels in sequential order to these stored settings.	*RCL
RELAY < on/off >	Generates error 203. This Option 750 capability is not supported.	None
RELAY?	Generates error 203. This Option 750 capability is not supported.	None
RIRST < ch >	Resets all protection functions for the specified channel. This Option 750 capability is supported	OUTP:PROT:CLE
ROM?	Queries the revision of the power system's firmware.	*IDN?
SROM?	Queries the revision of the power system's firmware.	*IDN?
SRQ < setting >	Does nothing.	*SRQ
SRQ?	Always returns a 0.	*SRQ?
STO <reg>	Stores the present settings for all output channels in the specified register. These settings can be recalled when desired.	*SAV
STS? <ch>	Queries the present status of the specified output channel. The response represents the sum of the binary weights of the status register bits.	STAT:OPER:COND? STAT:QUES:COND?
TEST?	Always returns a 0.	*TST?
UNMASK <ch>, <setting>	Sets the bits in the mask register of the specified output channel to the setting. The setting is an integer that represents the sum of the binary weights of the bits. The mask register operates in conjunction with the status and fault registers.	STAT:OPER:NTR STAT:OPER:PTR STAT:QUES:NTR STAT:QUES:PTR
UNMASK? <ch>	Queries the present setting of the mask register of the specified output channel. The response is an integer from 0 to 255.	STAT:OPER:NTR? STAT:OPER:PTR? STAT:QUES:NTR? STAT:QUES:PTR?
VDATA <ch>, <Vlo>, <Vhi>	Generates error –113. Unit must be calibrated using SCPI commands.	see Appendix B
VHI <ch>	Generates error –113.	None
VLO <ch>	Generates error –113.	None

Agilent 662xA Command	Description	Similar SCPI Command
VMUX? <ch>, <input>	Generates error –113.	None
VOUT? <ch>	Queries the measured output voltage of the specified output channel. The response is a real number. The front panel display can be used to monitor the measured output voltage (and current) of the selected output channel.	MEAS:VOLT?
VRLO <ch>	Generates error –113.	None
VRHI <ch>	Generates error –113.	None
VRSET <ch>, <x>	Sets the full-scale voltage range programming for an output channel. The power system will select the lowest operating range that will contain the value (x). If the present operating voltage is greater than the full-scale range selected, the present output voltage will be reduced to the full-scale value of the new range selected. If the voltage entered is larger than the highest possible range, an error message will result.	None
VRSET? <ch>	Queries the full scale voltage range setting of an output channel.	None
VSET <ch>, <voltage>	Sets the voltage of the specified output channel.	VOLT
VSET? <ch>	Queries the present voltage setting of the specified output channel. The response is a real number.	VOLT?
VSTEP <ch>, <x>	Increases or decreases the output channel voltage in steps. If the step value < x > is positive, output voltage will increase by the step value, if the step value is negative, the output voltage will decrease by the step value. Trying to step beyond the operating range will cause a number range error.	LIST:VOLT

Index

A

ABOR ACQ, 97
ABOR TRAN, 97
airflow, 17, 115

C

calibration, 133
  current downprogrammer, 139
  current programming and measurement, 137
  enable, 134
  equipment, 118
  low range current measurement, 139
  low range current programming, 138
  low range voltage, 135
  low range voltage measurement, 136
  password, 73, 141
  peak current limit, 140
  procedure, 134
  save and exit, 141
  switches, 133, 155
  voltage common mode rejection, 136
  voltage programming and measurement, 134
calibration commands
  CAL CURR, 72
  CAL CURR PEAK, 72
calibration commands, 72
  CAL CURR MEAS, 72
  CAL DATA, 72
  CAL DATE, 72
  CAL DPR, 72
  CAL LEV, 72
  CAL PASS, 73
  CAL SAVE, 73
  CAL STAT, 73
  CAL VOLT, 73
  CAL VOLT CMRR, 73
  CAL VOLT MEAS, 73
Caution, 3
CC, 89
  load effect, 124
  source effect, 124
channel
  location, 17
  parameter, 63
  range, 63
cleaning, 17
CME, 92
combining commands, 61
command
  combining, 61
  completion, 66
  coupling, 62
  synchronization, 66
common commands, 67
  *CLS, 91
  *ESE, 92
  *ESR?, 92
  *IDN?, 95
  *OPC, 92
  *OPT?, 95
  *RCL, 95
  *RDT?, 96
  *RST, 96
  *SAV, 96
  *SR, 93
  *STB?, 93
  *TRG, 98
  *TST, 96
  *WAI, 93
  combining, 61
compatibility
  command summary, 163
  differences, 162
  models, 161
connections
  multiple load, 20
  negative voltage, 20
  parallel, 23
  positive voltage, 20
  remote sensing, 22
  series, 24
control port
  connector, 144
conventions used in this guide, 64
coupled commands, 62
CP–, 90
CP+, 90
current
  measurement range, 46, 75
  monitoring resistor, 119

output range, 81
programming accuracy, 123
readback accuracy, 123
returning current data, 56
current limit
setting, 29, 40
CV, 89
load effect, 120
noise, 121
source effect, 121
CV operating mode
outputs in parallel, 23
outputs in series, 25

D

damage, 15
DDE, 92
description
front panel display, 11
overview, 8
device clear, 66
digital I/O
configuring, 149
connections, 146
digital input
configuring, 149
connections, 147
digitizer
programming, 54
programming example, 104
dimensions, 15, 115
disassembly, 153
tools required, 153

E

electronic load, 119
electrostatic discharge precautions, 153
environment
conditions, 15
ERR, 93
error messages, 156
ESB, 93
EXE, 92
external trigger
configuring, 148
connections, 145

F

fault output
configuring, 148
connections, 145
fetch commands, 45, 74
FETC ARR CURR?, 74
FETC ARR VOLT?, 74
FETC CURR?, 75
FETC VOLT?, 75
front panel
display, 11
menus, 32
screen saver, 47
front panel menu
exiting, 31
using, 30

G

GPIB
interface, 34
ground, earth, 15
guide, user's, 4

H

Hanning, 55
header, 63
long form, 63
short form, 63

I

inhibit input
clearing, 145
configuring, 148
connections, 145
initiate commands
INIT NAME, 97
inspection, 15
installation, 15
installing
modules, 153
instrument
identification, 46
storing states, 47
interface communication, 34
items supplied, 14

L

LAN
  interface, 35
list
  arbitrary, 52
  programming example, 102
lists
  programming, 49
load
  connections, 18
location, 17
lockout
  front panel, 47, 48

M

MAV, 88, 93
measure commands, 45, 74
  MEAS ARR CURR?, 74
  MEAS ARR VOLT?, 74
  MEAS CURR?, 75
  MEAS VOLT?, 75
measurement trigger
  generate, 58
  initiate, 58
  source, 57
measurements
  arrays, 56
  converter, 56
  Hanning window, 55
  making, 45
  Rectangular window, 55
  sample interval, 54
  simultaneous V and I, 45
message terminator, 64
  end or identify, 64
  newline, 64
message unit
  separator, 64
model
  differences, 9
  numbers, 14
MSS, 87, 93
multiple load
  connections, 20
multipliers, 65

N

numeric data formats, 65

O

OC, 90
OFF, 89
OPC, 92
OPER, 93
operating checklist, 152
operation status group, 87
optional header
  example, 61
options, 14
OT, 90
outline diagram, 15
output
  enable, 29, 40, 41
  noise, 22
  programming example, 100
  pulse, 50
  queue, 88
  turn-on delay, 41
output commands, 77
  OUTP, 77
  OUTP DEL FALL, 77
  OUTP DEL RISE, 78
  OUTP INH MODE, 78
  OUTP PON STAT, 78
  OUTP PROT CLE, 79
  OUTP PROT COUP, 79
  OUTP PROT DEL, 79
  OUTP REL, 79
output step
  programming, 42
output trigger
  enable, 42
  generate, 44
  initiate, 44
  level, 43
  source, 43
OV, 90
over-current
  protection, 41
over-voltage
  protection, 41
over-voltage protection
  setting, 30

P

PF, 90
PON, 92
power cord
  connecting, 17
power receptacle, 15
pre-trigger data, 54
print
  date, 2
  history, 2
PROT, 90
protection
  clearing, 42
pulse, 50

Q

QUE, 92
query
  description, 61
  indicator, 63
QUES, 93
questionable status group, 87

R

rack mounting, 16
Rectangular, 55
remote interface
  factory settings, 38
remote sensing
  description, 21
removing
  modules, 153
repackaging, 152
repacking, 15
reset states, 71
response data types, 65
root specifier, 64
RQS, 87, 93

S

safety, 3
  class, 15
  warning, 15
sample interval, 54
SCPI
  command completion, 66
  common commands, 71
  device clear, 66
  header path, 60
  message structure, 62
  message unit, 63
  multiple commands, 60
  program message, 62
  response message, 62
  subsystem commands, 68
screen saver
  front panel, 47
self-test, 46
sense commands
  SENS CURR RANG, 75
  SENS FUNC, 75
  SENS SWE OFFS POIN, 75
  SENS SWE POIN, 76
  SENS SWE TINT, 76
  SENS VOLT RANG, 76
  SENS WIND, 76
sense leads
  open, 22
source commands, 80
  [SOUR] CURR [IMM], 80
  [SOUR] CURR MODE, 80
  [SOUR] CURR PROT STAT, 80
  [SOUR] CURR RANG, 81
  [SOUR] CURR TRIG, 80
  [SOUR] DIG INP?, 81
  [SOUR] DIG OUTP, 81
  [SOUR] DIG PIN FUNC, 82
  [SOUR] DIG PIN POL, 82
  [SOUR] LIST COUN, 83
  [SOUR] LIST CURR, 83
  [SOUR] LIST DWEL, 83
  [SOUR] LIST STEP, 84
  [SOUR] LIST TERM LAST, 84
  [SOUR] LIST TOUT BOST, 84
  [SOUR] LIST TOUT EOST, 84
  [SOUR] LIST VOLT, 85
  [SOUR] STEP TOUT, 85
  [SOUR] VOLT [IMM], 85
  [SOUR] VOLT MODE, 85
  [SOUR] VOLT PROT [LEV], 86
  [SOUR] VOLT PROT STAT, 86
  [SOUR] VOLT RANG, 86
  [SOUR] VOLT TRIG, 85
specifications
  characteristics, 110
  performance, 108

standard event status group, 87
status byte, 87
status commands, 87
  STAT OPER COND?, 89
  STAT OPER ENAB, 89
  STAT OPER NTR, 90
  STAT OPER PTR, 90
  STAT OPER?, 89
  STAT PRES, 89
  STAT QUES COND?, 90
  STAT QUES ENAB, 91
  STAT QUES NTR, 91
  STAT QUES PTR, 91
  STAT QUES?, 90
step
  programming, 42
storing states, 47
subsystem commands, 67
suffixes, 65
support rails, 16
synchronizing measurements, 56
system commands, 94
  SYST CHAN MOD?, 94
  SYST CHAN OPT?, 94
  SYST CHAN SER?, 94
  SYST COMM RLST, 94
  SYST ERR?, 95
  SYST VERS?, 95
system protection
  connections, 146

T

test extensions, 49, 54, 56
transient recovery time, 122
transient trigger
  generate, 45
trigger commands, 97
  TRIG, 98
  TRIG [TRAN] SOUR, 98
  TRIG ACQ, 97
  TRIG ACQ SOUR, 97
turn-on delay, 41
types of SCPI commands, 60

U

UNR, 90
USB
  interface, 37

V

verification, 118
  equipment, 118
voltage
  measurement range, 46, 76
  output range, 86
  programming accuracy, 120
  readback accuracy, 120
  returning voltage data, 56
  setting, 28, 40

W

Warning, 3
warranty, 2
Web server, 48
web URL's, 4
wire sizes, 19
WTG-meas, 89
WTG-tran, 89

Agilent Technologies

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

CE

	Responsible Party	Alternate Manufacturing Site
Manufacturer's Name:	Agilent Technologies, Inc.	Agilent Technologies (Malaysia) Sdn. Bhd
Manufacturer's Address:	550 Clark Drive, Suite 101 Budd Lake, New Jersey 07828 USA	Malaysia Manufacturing Bayan Lepas Free Industrial Zone, PH III 11900 Penang, Malaysia

Declares under sole responsibility that the product as originally delivered

Product Name: Modular Power System

Model Numbers: N6700
N6731A, N6732A, N6733A, N6734A, N6735A
N6742A, N6743A, N6744A, N6745A
N6751A, N6752A, N6761A, N6762A

Product Options: This declaration covers all options of the above product(s)

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

Low Voltage Directive (73/23/EEC, amended by 93/68/EEC)
EMC Directive (89/336/EEC, amended by 93/68/EEC)

and conforms with the following product standards:

EMC	**Standard** IEC 61326 :1997+A1 :1998+A2 :2000 EN 61326 :1997+A1 :1998+A2 :2001	**Limit**
	CISPR 11:1997 / EN 55011:1998	Group 1 Class A
	IEC/EN 61000-4-2:1995+A1:1998 +A2:2001	4 kV CD, 8 kV AD
	IEC/EN 61000-4-3:2002	3 V/m, 80-1000 MHz, 80% AM
	IEC 61000-4-4:1995+A1 :2000 / EN 61000-4-4:1995+A1 :2(	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:1995+A1 :2000 / EN 61000-4-5:1995+A1 :2(	0.5 kV differential, 1 kV common mode
	IEC 61000-4-6:1996+A1 :2000 / EN 61000-4-6:1996+A1 :2(	3 Vrms, 0.15-80 MHz, 80% AM
	IEC 61000-4-11:1994+A1 :2000 / EN 61000-4-11:1994+A1	100%/20 ms
	IEC 61000-3-2 +Amd 2:1998, EN 61000-3-2: 1995 + Amd. 1/2:1998+A14: 2000	Harmonic Current Emission per std
	IEC 61000-3-3: 1994 + A1:2001, EN 61000-3-3: 1995 + A1:	Voltage Fluctuations and Flicker per std
	Canada: ICES-001:1998 Australia/New Zealand: AS/NZS 2064.1	
	The product was tested in a typical configuration with Agilent Technologies test systems.	
Safety	IEC 61010-1:2001 / EN 61010-1:2001 Canada: CSA C22.2 No. 1010.1:1992 UL 61010B-1: 2003	

Supplementary Information:

This DoC applies to above-listed products placed on the EU market after:

January 1, 2004

Date

Bill Darcy
Product regulations manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor, or Agilent Technologies Deutschland GmbH, Herrenberger Straße 130, D 71034 Böblingen, Germany.